Marine Engineering

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NEW STEAMSHIP MONGOLIA, FOR THE PACIFIC MAIL STEAMSHIP COMPANY.

The New York Shipbuilding Company, Camden, N. J., has just delivered to the Pacific Mail Steamship Company the latest product of American shipbuilding in the twin screw steamer *Mongolia*. This vessel left Norfolk, Va., on the 20th of February for San Francisco and will run between San Francisco and Japanese and Chinese ports. As in 1902, the Pacific Mail Steamship Company brought out the two largest vessels then built in the United States, viz: the *Korea* and the *Siberia*,* so to-day they still hold this record with the *Mongolia* and her sister ship, the *Manchuria*, which is fitting out at Camden, and which will be delivered shortly.

NEW PACIFIC MAIL TWIN SCREW STEAMSHIP MONGOLIA.

The principal dimensions are given below and further data will be found in the card on page 160.

Length	615 ft. 8 in.
Breadth	65 ft. 0 in.
Depth to shelter deck	51 ft. 3 in.
Load draft	33 ft. 6 in.
Registered gross tonnage	13,639 tons.

The latest experience has been used in making these vessels the most efficient of their class and the safest for the transport of passengers and cargo. A strict inspection has been given them as is shown by the fact that the American Bureau of Shipping has given them the highest rating and the Lloyd's Register of British and Foreign Shipping has classed them 100-A1, Special Survey; the Bureau Veritas has accorded them the highest class and they conform to all the requirements of the Board of Supervising Inspectors of steam vessels of the United States, and the British Board of Trade.

HULL CONSTRUCTION.

The structural material is steel and has been tested to the requirements of the classification societies, and the scantlings are also in accordance with their rules.

The keel is of the flat plate type, with a horizontal bar keel fitted, 3 inches thick. The center keelson is continuous all fore and aft. The stern frame is of cast steel, in two pieces, and is arranged with an aperture between the propellers. The shaft brackets are of cast steel and of the spectacle type with the shell plating carried right

* For complete description and plans see MARINE ENGINEERING, May, 1902.

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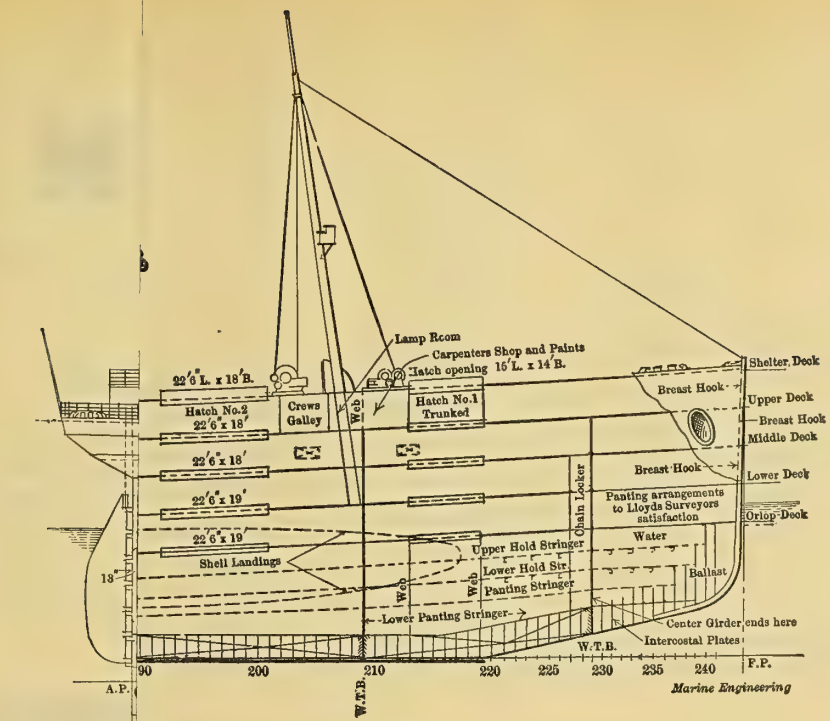
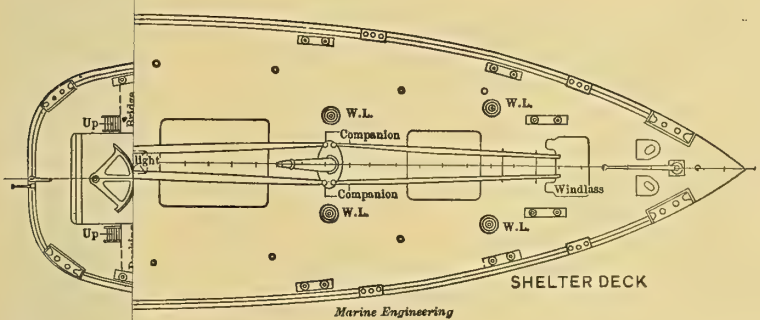
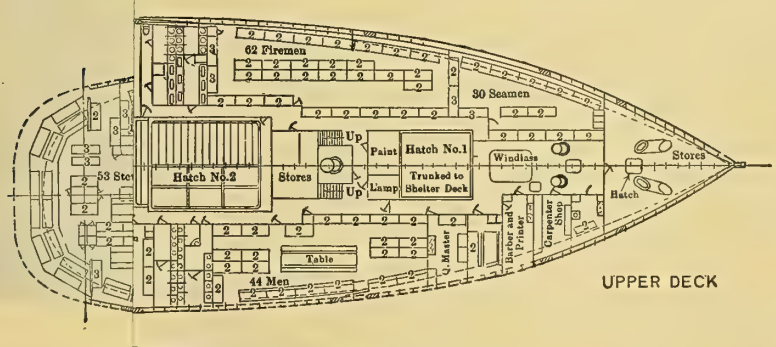
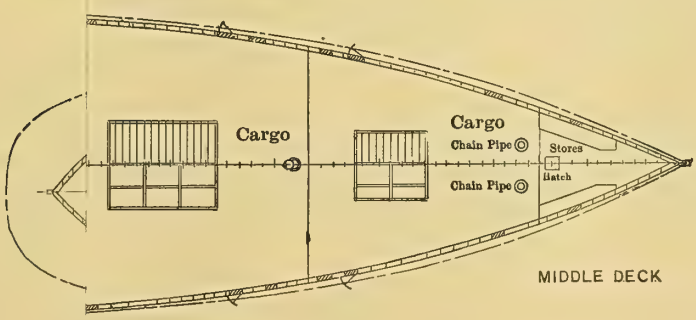


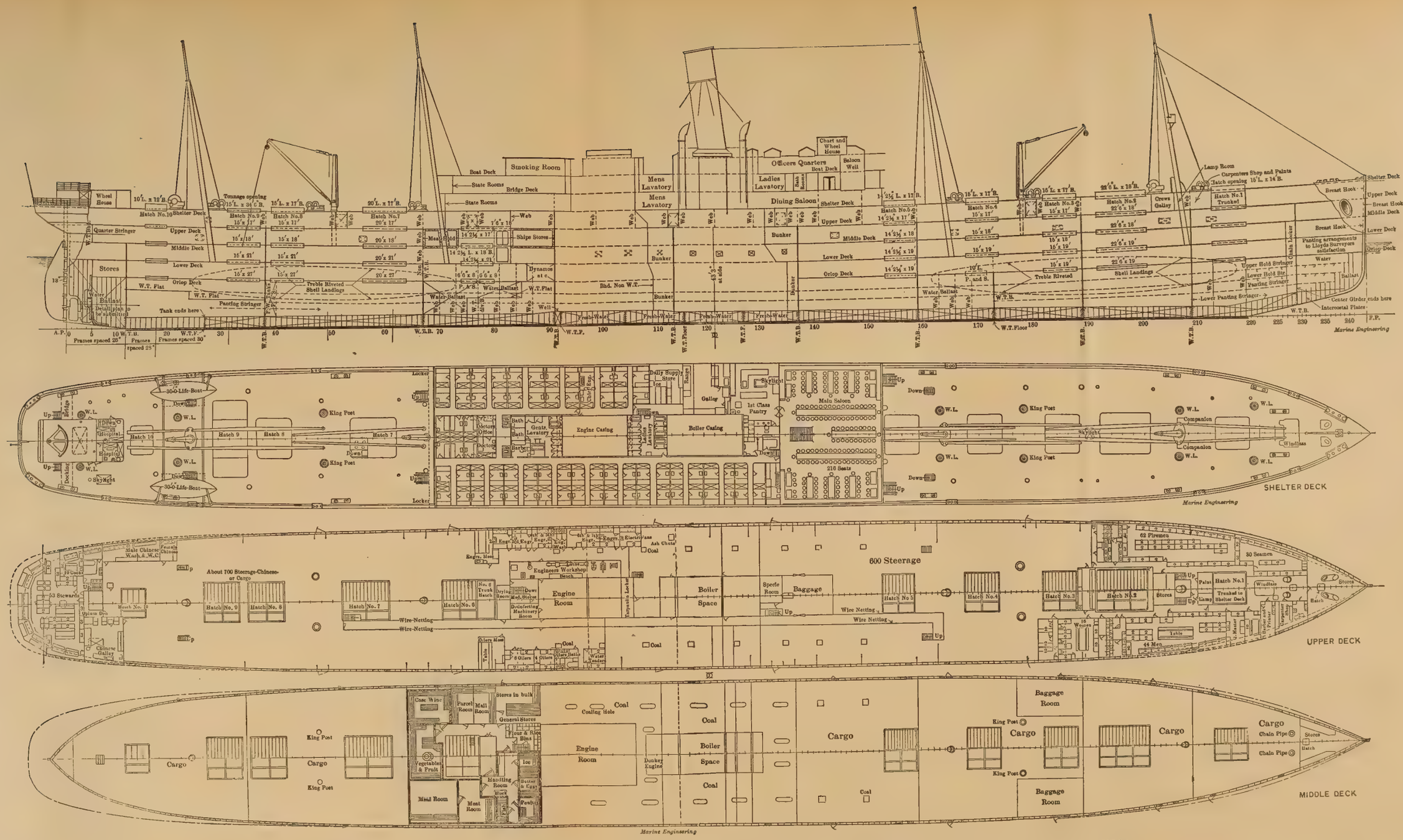






:HURIA,

SUPPLE



INBOARD PROFILE AND DECK PLANS OF THE NEW 600-FOOT TRANSPACIFIC TWIN SCREW STEAMSHIPS MONGOLIA AND MANCHURIA, BUILT BY THE NEW YORK SHIPBUILDING COMPANY FOR THE PACIFIC MAIL STEAMSHIP COMPANY.

aft and riveted to the brackets. The rudder is of the single plate type, the stock being of wrought steel, the rudder frame and arms of cast steel in one piece and coupled to the stock. The stem is in two pieces, the lower portion being of cast steel and the upper a forging.

The double bottom extends all fore and aft and has solid floors on every frame with three longitudinals on each side between the center keelson and the margin plate. Extra keelsons are fitted at the fore end and under the engine. The capacity of the double bottom is 2,270 tons of water and is arranged so that fresh water can be carried for the use of the boilers or the ship The peaks are fitted as trimming tanks. Besides the water ballast in the double bottom there are three deep tanks, one fitted forward and two abaft the engine room. There is a total weight of water ballast of 4,600 tons.

Special consideration has been given to the riveting of the shell plating. The spacing of the rivets has been increased in certain parts. The rivets are all machine riveted, the sheer strake and two strakes below having button points for more than half the length of the vessel. Special compensation is fitted in the way of the cargo ports, coal ports and sidelights.

The *Mongolia* has five complete decks: orlop, lower, middle, upper and shelter; over the accommodation amidships are the bridge and boat decks. In earlier vessels of this type, the strength deck was at the upper deck, but in the *Mongolia* it was raised to the shelter deck and the ends of the superstructure have been strengthened so as to overcome the weakness shown in earlier vessels. There are 10 water-tight bulkheads which run up to the upper deck. A non-water-tight center line bulkhead is fitted from the top of the inner bottom to the orlop deck; this greatly adds to the strength and serves as a shifting board when carrying grain cargoes.

The coal bunkers are arranged at each end of the boiler space and contain a permanent supply of 1,950 tons, with a reserve bunker at the fore end capable of increasing this amount by 2,800 tons. Coaling hatches are conveniently arranged on the upper deck, and side ports are also fitted on the sides of the vessel for loading coal from barges.

PASSENGER ACCOMMODATIONS.

The first-class passenger accommodation is in the midship house on the shelter and bridge decks.

SHELTER DECK.

On the shelter deck at the fore end is the dining saloon which has seats for 216 and extends from side to side of the vessel. The sides and ends are finished in dark oak with a dull finish, the panels between beams are staff, and the coloring of the ceiling is white and gold. The type of sidelights at the fore end is a combination port and rectangular ventilator which can be opened from the inner side; on the sides of the saloon circular ports are fitted. All these sidelights have Venetian sliding shutters. There is a light well over the center of the saloon which is lighted through a skylight over the music room above. At the after end of the dining saloon is the grand stairway which leads up to the social hall on the bridge deck.

Immediately abaft the dining saloon on the starboard side of the shelter deck is the purser's office fitted up with desk, safe, etc., and on the opposite side of the starboard passageway is the steward's office and a stairway leading down to the baggage-room.

From the purser's office right aft on the starboard side, across the after end of the deck-house end extending on the port side as far forward as the engine casing, the first-class staterooms are arranged. These rooms are fitted up with four beds, two of them being Hoskins, and the sofa and sofa back forming the other two. Beautiful mahogany fold-up lavatories and electro-plated fittings are supplied to all these rooms, with red curtains to sidelights, beds and doors. The inner rooms are well ventilated through rectangular trunk ventilator fitted to the deck-house coaming on the bridge deck.

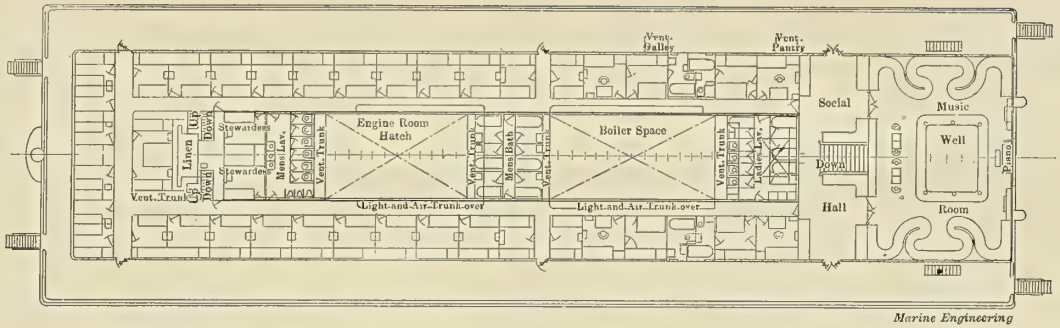
Between the engine and boiler casing and immediately abaft of the engine casing are located the ladies' and men's lavatories, fitted up with wash basins, pier glasses, etc., well ventilated and having the floor mosaic tiled. The doctor's room, dispensary and barber shop are conveniently situated on this deck.

Abreast of the engine casing on the port side are rooms for the chief engineer, first assistant engineer, chief steward, second steward, storekeeper and freight clerks, and immediately on the fore side of these rooms are the daily supply store, butcher shop, galley and pantry, the latter opening into the dining saloon. The butcher shop and daily supply store are fitted up with all the necessary chopping blocks, shelves and bread bins, and each has an ice-box. In one corner of the main galley is a bakery. The first class pantry is spacious and fitted up with hot press, dish wagon and all the necessary silver lockers and racks An elevator is used for serving to the officers' pantry and for light refreshments on the boat deck.

BRIDGE DECK.

The grand stairway in the main saloon leads to the social hall or entrance on the bridge deck, the panelling of which is the same as the saloon, dark oak with a dull finish. A skylight with decorated leaded glass gives light and ventilation to the stairway and social hall. On the forward side of the social hall is the music room, which is finished in white and gold and tapestried furnishings. A large skylight with decorated leaded glass surmounts the well in the center of the music room. A piano is placed in the fore side, sidelights have cathedral glass in sliding windows.

Two suites of rooms on each side are arranged immediately abaft the social hall, which consist of sitting-room, bed-room and bath-room. The sitting-room is furnished with writing table, folding lavatory, wardrobe, and the bed-room has a large brass bedstead, sofa and wardrobe. The furniture is of dark mahogany, and the paneling of sides and ceiling is painted white. Large staterooms for three persons, similarly fitted up to the staterooms on the shelter deck, are arranged around the bridge deck-house. The lavatories and baths are located in the center of the deck-house, and like the sanitary accommodation of the shelter deck, have fine ventilation. There is a good promenade on each side of this bridge deck with the boat deck as a shelter.



BRIDGE DECK OF THE MONGOLIA. FOR OTHER DECK PLANS SEE THE INSET.

BOAT DECK.

On the boat deck, at the fore side of the boiler casing, is a large deck-house containing the captain and officers' quarters. The captain's bedroom is furnished in mahogany and opens into a large day room which is paneled in white and furnished with a large mahogany roll top desk, table and chairs. The officers' mess room is on the starboard side and conveniently located to the pantry, which is supplied by an elevator from the main galley.

Abaft the engine casing is the smoking-room and bar, which is paneled in Flemish oak, and with a frieze of paneling at the top depicting Dutch water scenes. Sliding shutters are fitted with leaded glass depicting drinking scenes, comfortable leather-covered settees, card tables and revolving chairs are provided.

Two stairways on the after end lead to the bridge deck. The lifeboats are arranged to stow on deck and to hang overboard at sea, thus enabling the passengers to use the sides of this deck for a promenade.

Above the officers' quarters is a house containing the wheel and chart room; an extension of the roof of this wheel house give protection to the steering wheel, telegraphs and compass.

UPPER DECK.

On the upper deck forward on the port side are rooms for the seamen, firemen and their sanitary quarters. On the starboard side are the rooms for quartermasters and petty officers, together with rooms for steerage passengers. On this deck on each side of the engine casing are rooms for the engineers, electricians, oilers and water tender, and at the after end are located the stewards and cooks. The remainder of this deck can be used for light cargo or steerage, and in the event of Chinese steerage being carried, a Chinese galley and wash places have been fitted at the stern.

On the upper deck abaft of the engine room a very large refrigerating space has been arranged convenient to the galley, and divided up with rooms for butter and eggs, poultry and game, wine, vegetables and fruit and meat.

The vessel has four masts, with fore-and-aft sails, and is fitted with derricks on all these masts for the rapid handling of freight.

MAIN ENGINES.

The vessel is twin screw with engines of 10,000 I.H.P. The engine room is very spacious, extending the entire width of the ship, and 45 feet 6 inches fore and aft. All this area is available with the exception of the small corner spaces occupied by the engine room wing bunkers. The absence of a midship bulkhead between the engines still further adds to the appearance and spaciousness of the engine room. The height from the engine-room floor plates to the skylights is 70 feet.

The engines are four-cylinder, quadruple expansion of the usual marine type, with Stephenson link valve motion. The diameter of the cylinders are 30, 43, 63 and 89 inches, with a common stroke of 5 feet. The designed pressure at the engines is 200 pounds. The propellers turn outboard. The cylinders are arranged from forward aft, as follows: High pressure, second intermediate, low and first intermediate. The length between centers is 8 feet 5 inches, 14 feet 3 inches and 8 feet 5 inches respectively.

The cylinders are supported on eight cast iron housings of box-section. The two forward back housings and the four front housings run clear from the cylinder feet to bed plate; the two after back housings run to the top of condenser, which extends only half the length of engines from the after end. The cylinders are free to expand independently of each other, each one

being bolted only to its own housings, while the housings are joined at their upper ends by horizontal cast iron girders of box section. This construction has been adopted by the New York Shipbuilding Company for its engines, as it gives a very secure connection, while at the same time it allows independent expansion of the cylinders. The overhang of the L.P. valve chest is carried on shoes which are free to move on the horizontal girders.

The bed-plate is of cast iron, in four parts, of box section throughout, with lightening holes reinforced. The columns are fitted with handhole plates and utilized as oil tanks.

The main valves are of the piston type, with the

TABLE OF EQUIPMENT AND SCANTLINGS OF THE MONGOLIA AND MANCHURIA.

EQUIPMENT.

3 Bower anchors, stockless, of 119 1-4 cwt. each.
1 Stream anchor, stockless, of 48 3-4 cwt.
1 Kedge anchor, stockless, of 26 1-4 cwt.
Stud chain cable, 330 fathoms 3 2-16.
Stream cable, 150 fathoms 6 1-2 in. steel wire.
Tow line, 140 fathoms 7 1-2 in. steel wire.
Hawsers, three 120 fathoms each, 8 in. Manilla.
Wards, three 120 fathoms each, 8 in. Manilla.

SCANTLINGS.

Frames: Spaced 30″ except in peaks where they are spaced 26″ and for 6 spaces inboard which are spaced 28″, 9″ x 4″ x 4″ x 13-20″ channel for 3-5ths L., 9″ x 3.9″ x 3.9″ x 11-20″ bet. 3-5th L., and 3-4ths L. and 9″ x 3.85″ x 3.85″ x 10-20″ at ends. In peaks 6″ x 4″ x 12-20″ angle. In double bottom 4″ x 4″ x 11-20″ doubled from 3-5ths L. ford. to collision bulkhead. 4″ x 4″ x 12-20″ under boilers.

Bulkhead frames double 5″ x 4″ x $\frac{13\text{-}12''}{20}$ to shell

Bulkhead angles to tank top 4″ x 4″ x $\frac{10\text{-}9''}{20}$ and to all decks 3 1-2″ x 3 1-2″ x 10-20″.

All frames to extend to shelter deck.

Frames from No. 19 to No. 28, inclusive, to be 6 1-2″ x 4″ x 11-20″ angle.

Bossed angles from No. 13 to No. 18 inclusive to be 6 1-2″ x 4″ x 11-20″ angle.

Frames from margin plate to orlop deck doubled in Nos. 1 and 2 holds, with 6″ x 4″ x 11-20″ angles on every frame in No. 1 and every alternate in No. 2.

In engine space every alt. frame (9″ x 4″ x 4″ x 13-20″ channel) to be doubled from margin plate to middle deck stringer. In boiler space every frame will be thus doubled.

Reverse Frames: In peaks 6″ x 4″ x 11-20″ to extend alternately to shelter and upper decks. In holds 4″ x 4″ x 12-20″. On alternate frames to lower edge of orlop deck beam knee. In double bottom 3 1-2″ x 3 1-2″ x 10-20″, at W. T. floors 4″ x 4″ x 11-20″. Under engine and boiler space 3 1-2″ x 3 1-2″ x 11-20″ doubled. From No. 19 to No. 28, inclusive, to be 6″ x 4″ x 11-20″ angle.

Bulkheads: Plating 8-20″ to 7-20″.

Bulkhead web stiffeners 15″ x 3.426″ x 3.426″ x 35 lbs.

Shaft Tunnel: 8-20″ plating and 5″ x 4″ x 11-20″ angle stiffeners, spaced 4′ c. to c. under hatches. Stiffeners are spaced 3′ c. to c. additional stiffeners are to be fitted where pillars heel on tunnel top.

Stem: 12″ x 4″ W. I. Lower part of cast steel.

Stern Post: 13″ x 6″ cast steel.

Rudder Head: 15 1-4″ dia. Pintles 7 5-8″.

DECK PLATING.

Bridge Deck: 5-20″ double riveted butt laps, landing single riveted 5-8″ rivets. Stringer: triple riveted butt laps, 3-4 rivets.

Shelter Deck: 8-20″ at ends double riveted butt laps for 1-2 L. Double riveted at ends. Landings single riveted. Rivets 7-8″ and 3-4″ dia. Plating between hatches 10-20″. Stringer: Triple riveted double butt straps 13 11-20″ for 1-2 L., triple riveted single straps at ends, 2-20″ thicker than plates Doubling plate, triple riveted double butt straps for 1-2 L. 12 10-20″ triple riveted. Single straps at ends of 1″ rivets.

Upper Deck: 11-20″ for 1-2 L. 8-20″ at ends. Treble riveted butt laps for 1-2 L. Double riveted at ends. Landings single riveted. 7-8″ rivets amidships, 3-4″ at ends. Plating between hatches 8-20″. Stringer: triple riveted double butt straps for 1-2 L., triple riveted single straps at ends, single straps 2-20″ thicker than plates. 1 1-2″ rivets amidships, 1″ rivets at ends.

Middle Deck: 9-20″ for 1-2 L. 8-20″ at ends. Double riveted lap butts for 1-2 L. Single riveted lap butts at ends. Landings single riveted. 3-4″ rivets. Plating between hatches 8-20″. Stringer: triple riveted lap butts for 1-2 L, double riveted lap butts at ends. 1″ rivets amidships, 7-8″ at ends.

Lower Deck: 8-20″ for 1-2 L., 7-20″ at ends. Double riveted lap butts for 1-2 L. Single riveted lap butts at ends. Landings single riveted. 3-4″ rivets. Stringer: triple riveted lap butts for 1-2 L., double riveted lap butts at ends, 7-8″ rivets.

Orlop Deck: 7-20″ throughout. Double riveted lap butts for 1-2 L. Single riveted lap butts at ends. Landings single riveted. 3-4″ rivets. Stringer same as lower deck.

Bar Keel: 1 1-4″ rivets spaced 5 diams. center, butts to be scarfed 28″ long.

Keel: Treble riveted double butt straps all F. & A. butt straps both 15-20″ amidships, 13 11-20″ at ends, 1 1-8″ rivets amidships, 1″ rivets at ends.

SHELL PLATING.

A: Quadruple riveted lap butts for 1-2 L., treble riveted butts at ends. 1 1-8 and 1″ rivets

B, C, D and E: Quadruple riveted lap butts for 1-2 L., treble riveted lap butts at ends. Where outside strakes are less than 46″ and inside strakes are less than 54″, 1″ rivets.

F: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 46″ wide, 1″ rivets.

G: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

H: Quadruple riveted lap butts, 1″ rivets

J: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

K: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

M: Quadruple riveted lap butts, 1″ rivets.

N: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

O: Quadruple riveted lap butts 1″ rivets.

P. Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

R: Quadruple riveted lap butts, 1″ rivets.

S: Quadruple riveted lap butts for 1-2 L., treble riveted at ends, if under 54″ wide, 1″ rivets.

T: Quadruple riveted lap butts throughout

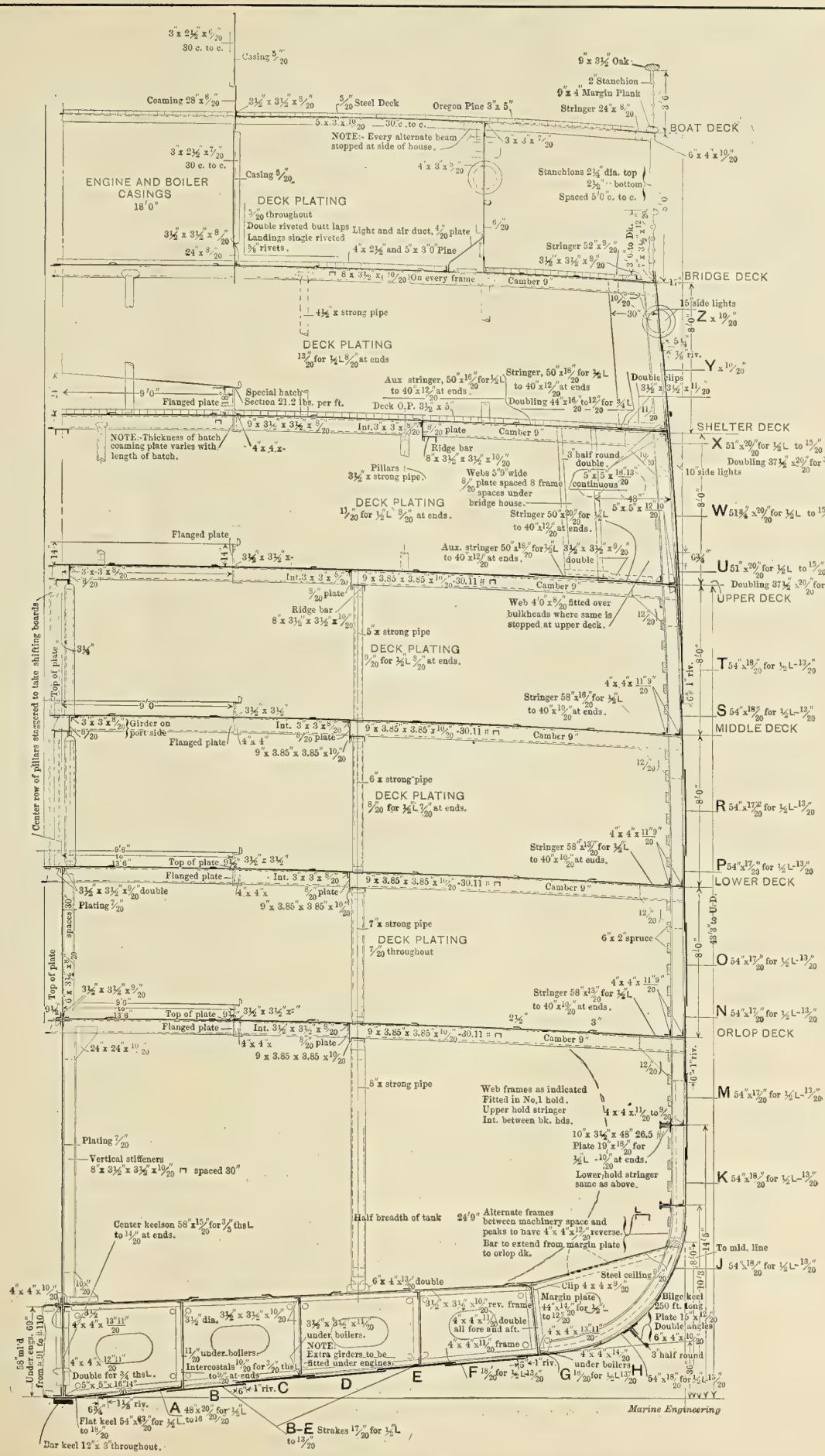
U: Treble riveted double butt straps $\frac{14\ \&\ 13''}{20}$ for 3-4 L. and treble riveted single butt straps, outside 2-20″ thicker than plates at ends. Rivets 1 1-8″ amidships, 1″ at ends, doubling 37 1-2 by 20-20″ for 3-5th L. Treble riveted double butt straps.

W: Treble riveted double butt straps $\frac{14\ \&\ 13''}{20}$ for 3-4 L. and treble riveted outside. Single butt straps (2-20″ thicker than plates) at ends, 1 1-8″ rivets amidships, 1″ rivets at ends.

X: Treble riveted double butt straps for 3-4 L. and treble riveted single outside butt straps at ends, straps $\frac{14\ \&\ 13''}{20}$ for 3-4 L. Straps at ends 2-20″ thicker than plates, doubling 37 1-2″ by 20-20″ for 3-5 L., with treble riveted double butt straps, 1 1-8″ rivets amidships, 1″ rivets at ends.

Y: Treble riveted butt laps fore and aft, 7-8″ rivets.

Z: Treble riveted butt laps fore and aft, 7-8″ rivets.


ENGINE AND BOILER CASINGS 18'0"
DECK PLATING
NOTE:- Every alternate beam stopped at side of house.
Stanchions 2½" dia. top 2½" bottom Spaced 5'0" c. to c.
Oregon Pine 3"x 5"
Steel Deck
Coaming 28"x 8/20
Casing 5/20
Light and air duct, 4/20 plate
4"x 2½" and 5"x 3"0" Pine
Landings single riveted
5/8" rivets.
Double riveted butt laps
BOAT DECK
BRIDGE DECK
SHELTER DECK
UPPER DECK
MIDDLE DECK
LOWER DECK
ORLOP DECK
Stringer 24"x 8/20
Stringer 52"x 9/20
9"x 3½" Oak
2" Stanchion
9"x 4" Margin Plank
6"x 4"x 10/20
15 side lights
Z x 10/20
Y x 10/20
Double clips 3½"x 3½"x 11/20
Aux. stringer, 50"x16/20 for ½L to 40"x12/20 at ends.
Stringer, 50"x18/20 for ½L to 40"x12/20 at ends
Doubling 44"x18/20 to 12/20 for ¾L
Deck O.P. 3½"x 5/20
Special hatch Section 21.2 lbs. per ft.
Flanged plate
NOTE.-Thickness of hatch coaming plate varies with length of hatch.
4"x 4"x-
Int. 3"x 3"x 8/20 plate
Camber 9"
Ridge bar 8"x 3½"x 10/20
Pillars 3½" x strong pipe
Webs 5'9" wide 8/20 plate spaced 8 frame spaces under bridge house.
3" half round double
5"x 5"x 18/13 continuous 20
10" side lights
W 51¾"x 20/20 for ½L to 15/20
Doubling 37½"x 20/20 for ⅗L
DECK PLATING 11/20 for ½L 8/20 at ends.
Stringer 50"x20/20 for ½L to 40"x12/20 at ends.
Aux. stringer 50"x18/20 for ½L to 40"x12/20 at ends.
3½"x 3½"x 9/20 double
U 51"x20/20 for ½L to 15/20
Doubling 37½"x20/20 for ⅗L
Web 4'0"x 8/20 fitted over bulkheads where same is stopped at upper deck.
5" x strong pipe
DECK PLATING 9/20 for ½L 8/20 at ends.
T 54"x18/20 for ½L-13/20
Stringer 58"x18/20 for ½L to 40"x10/20 at ends.
S 54"x18/20 for ½L-13/20
Girder on port side
9'0"
9"x 3.85"x 3.85"x 10/20 -30.11 # □
6" x strong pipe
DECK PLATING 8/20 for ½L 7/20 at ends.
R 54"x17/20 for ½L-13/20
Stringer 58"x13/20 for ¾L to 40"x10/20 at ends.
P 54"x17/20 for ½L-13/20
Top of plate 9'8" 13'8"
Plating 7/20
7" x strong pipe
6"x 2" spruce
O 54"x17/20 for ½L-13/20
Stringer 58"x13/20 for ½L to 40"x10/20 at ends.
N 54"x17/20 for ½L-13/20
24"x 24"x 10/20
8" x strong pipe
Web frames as indicated Fitted in No. 1 hold. Upper hold stringer Int. between bk. hds.
4"x 4"x 11/20 to 9/20
M 54"x17/20 for ½L-13/20
10"x 3½"x 48" 26.5 # Plate 19"x18/20 for ½L 10/20 at ends.
Lower hold stringer same as above.
Vertical stiffeners 8"x 3½"x 3½"x 10/20 □ spaced 30"
K 54"x18/20 for ½L-13/20
Center keelson 58"x15/20 for 3/5 ths L to 14/20 at ends.
Half breadth of tank
24'9"
Alternate frames between machinery space and peaks to have 4"x 4"x 12/20 reverse.
Bar to extend from margin plate to orlop dk.
To mld. line
J 54"x18/20 for ½L-13/20
Steel ceiling 9/20
Clip 4"x 4"x 9/20
6"x 4"x 13/20 double
Margin plate 14"x14/20 for ½L to 12/20
Bilge keel 250 ft. long. Plate 15"x12/20 Double angles 6"x 4"x 10/20
4"x 4"x 10/20
4"x 4"x 13"11/20
3½" dia.
3½"x 3½"x 10/20
3½"x 3½"x 11/20 under boilers.
NOTE: Extra girders to be fitted under engines.
3½"x 3½"x 10/20 rev. frame
4"x 4"x 11/20 double all fore and aft.
4"x 4"x 11/20 frame
4"x 4"x 14/20 under boilers
3" half round
4"x 4"x 12"11/20
Double for ¾ ths L.
5"x 5"x 16"14/20
11/20 under boilers.
Intercostals 10/20 for 5/20 thk to 9/20 at ends
6"x 1" riv.
Flat keel 54"x 8/20 for ½L to 18/20
Bar keel 12"x 3" throughout.
A 48"x20/20 for ½L to 16/20
B-E Strakes 17/20 for ½L to 13/20
Marine Engineering

MIDSHIP SECTION OF TWIN SCREW STEAMSHIPS MONGOLIA BUILT BY THE NEW YORK SHIPBUILDING COMPANY.

exception of the L. P., which is double ported slide. A piston valve of 16 5-8 inches diameter supplies the H.P., one of 22 inches supplies the 1st I. P. cylinder, while the 2d I. P. has two of 21 inches diameter, driven from a cast steel crosshead. The L. P. and 2d I. P. valve gears are balanced with the Lovekin-Thom assistant cylinder. These cylinders are located over the valve stems which have extensions for pistons as in ordinary balance cylinder. The 2d I. P. assistant cylinders take their steam from the L. P. receiver through a sleeve on the stem. The L. P. assistant cylinder takes its steam from the 1st I. P. receiver, reduced down to 85 pounds. This allows a small assistant cylinder to be used for the heavy gear. The smooth working of these heavy valve gears under normal conditions shows them to be relieved of all strains due to inertia and gravity. By throttling down the supply to the L. P. assistant cylinder it was observed that the consumption of steam was practically nothing. This accords with the theory of their design, there being no exhaust, as the desired balance is obtained simply by alternate compression and expansion arranged to suit the forces expected. The only consumption of steam is that due to losses by radiation and leakage.

The main pistons are conical. The H. P., 1st I. P., and L. P. are cast steel, and the 2d I. P. cast iron. Lockwood and Carlisle packing rings are used in the L. P. piston and others have three spring rings of the usual type. The follower bolts screw into composition plugs in the piston bodies. Metallic packing is used on the H. P. and 1st I. P. rods and valve stems; fibrous in all others.

The piston rods are of mild open-hearth forged steel, 9 inches diameter. The 2d I. P. and L. P. rods carry extension tail rods of 6 3-4 inches diameter. The crossheads are of same material as piston rods and secured by tapered fit. The crosshead shoes are cast iron, adjustable, lined with white metal. The connecting rods are also of mild steel, 11 feet 3 inches between centers, with fork end tops provided with phosphor bronze boxes.

The crank shafts are of the built-up type, mild steel, 18 inches diameter, with a 4-inch bored hole. The thrust, line and tail shafts are of the same material, 17 3-4 inches, 17 1-8 inches and 18 1-4 inches diameter, respectively, with 6-inch bored hole. The thrust shaft has 8 collars, 28 1-4 inches diameter, running between adjustable horseshoe bearings of the usual type. Around the flange on forward end of tail shafts a cast iron ring is fitted, and just aft of this, but clear of it, is a stop secured to the framing of the shaft boss. The purpose of this gear is to prevent the tail shaft working aft should breakage occur in the line shaft. Efficient trolley gear provides a means for quickly withdrawing tail shaft for examination, etc. The stern tubes are of cast iron in two sections. The nuts on the stern gland are worked by rack-gearing from a worm wheel and pinion.

The propellers are three-blade, built up with manganese bronze blades and cast iron hubs, arranged to allow adjustment of pitch from 21 feet 8 inches to 25 feet 4 inches. The diameter of tips of blades is 18 feet 6 inches.

The condensers are of cast iron, built in abreast of the two after cylinders. The tube-cooling surface of each is 7,500 square feet. The circulating water enters at the top and leaves at the bottom, passing through twice the length of tubes. The tubes are 3-4 inch outside diameter, of No. 18 B. W. G. brass, tinned inside and out. The tube sheets are of Muntz metal.

The direct connected pumps on each engine are attached to the condenser and operated by links from the 1st I. P. crosshead. The main air pump is 30 1-2 inches diameter, and 30 inches stroke. The other direct connected pumps are: one 6-inch feed pump, one 6-inch bilge pump, and one 5-inch fire and sanitary pump. There is also a 4 1-2 inch diameter by 15-inch stroke hot salt water pump on port engine only. Aspinwall inertia governors are fitted on the pump levers, and connected to the butterfly valves.

The reversing gear is of the "all-round" type, double 7 1-2 inch by 7 1-2 inch engines, secured to the inboard 2d I. P. housing. They are connected by worm gearing to the reverse shaft just above. The reversing engines are quickly and easily started and stopped by the change valve between steam and exhaust lines. The reverse arms are fitted with slots to allow independent linking up of all engines.

The turning gear engines are duplicates of the reversing engines and secured to the inboard side of each condenser. They connect by double worm gearing to a cast steel gear on main shaft.

AUXILIARIES.

There are four main feed pumps of the vertical simplex double-acting piston type, 11 and 8 inches by 26 inches stroke, built by Dean Brothers. These are similar in style to the well-known Weir pumps. Steam to these pumps is regulated by an automatic float in the suction chambers. The two auxiliary feed pumps are vertical duplex—12 and 7 inches by 12 inches, and 9 and 6 inches by 10 inches, also built by Dean Brothers. The feed water, after leaving the main feed pumps, passes through a Quiggins feed heater of the vertical cylindrical type. Steam to the coils of the feed heater is taken from high pressure or from main feed pump exhaust as desired. From the feed heater the feed passes through a Railton & Campbell grease extractor of the cartridge type, thence to the main boilers, through main or auxiliary lines. Ample connections allow the feed water to be handled in almost any way desirable or necessary, cutting out heater and filter, one or both, working from main or auxiliary feed pumps or direct connected pumps.

The main circulating pumps are centrifugal, with connections 16 inches diameter, driven by independent 10 by 10-inch vertical engines of the New York Shipbuilding Company's designs. The ballast pump is vertical duplex 12 and 14 by 12 inches. Two other vertical duplex pumps 6 and 6 by 6 inches, and 5 1-4 and 4 by 5 inches are for pumping fresh water for the various uses required. The independent water service and sanitary pump is also vertical duplex 7 and 8 by 8 inches.

A Wheeler auxiliary condenser of 1,050 square feet cooling surface is located on the port side middle platform, with its own air and circulating pumps attached, size 10 by 12 and 12 by 12.

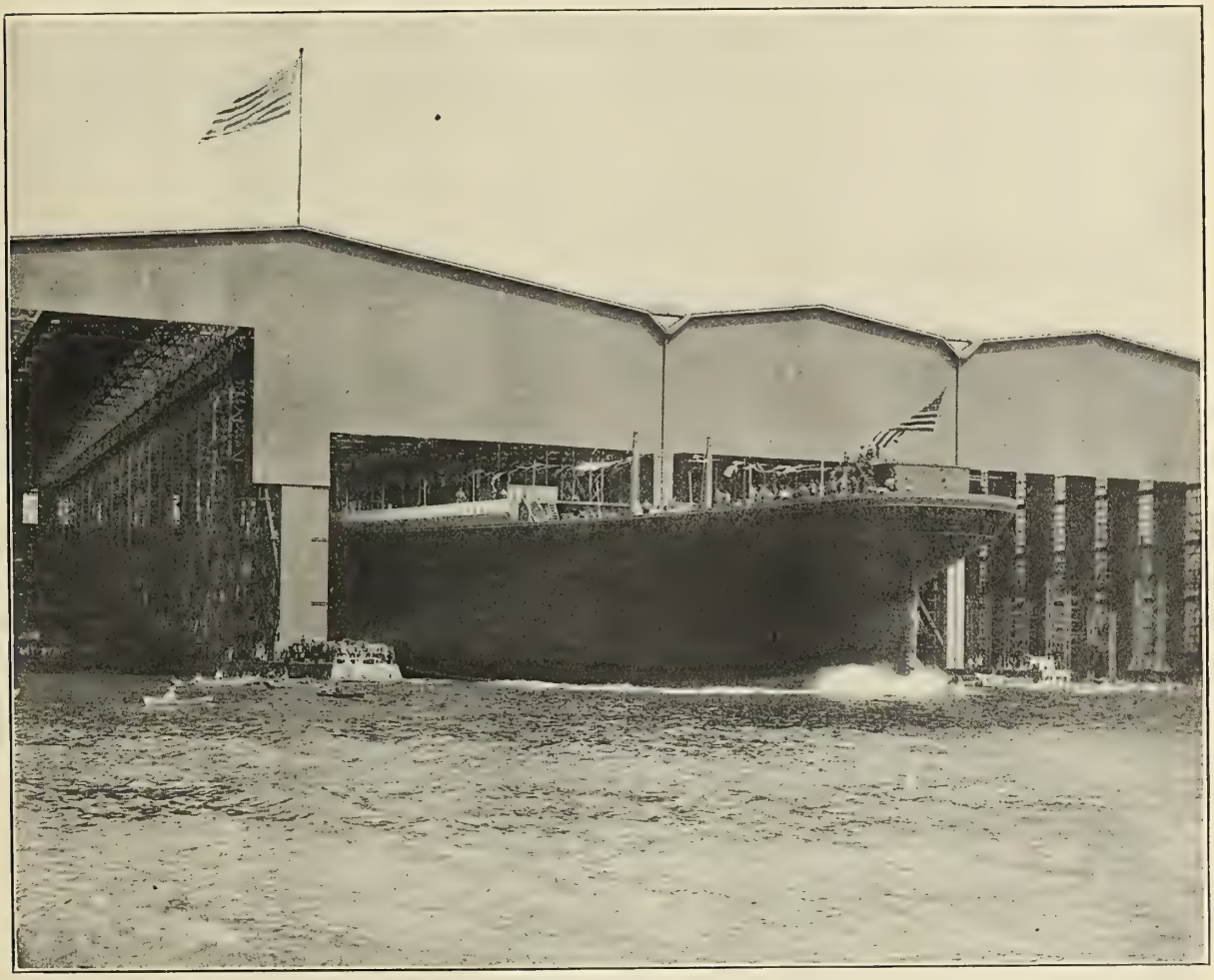
A Reilly evaporator is located below in forward end

of port engine room with a capacity of 50 tons of fresh boiler feed per 24 hours. In connection with this are the evaporator feed pump and two vertical cylindrical distillers of capacity of 5,000 gallons each per 24 hours. They are supplied with circulating water from the auxiliary duplex feed pumps or the ballast pump.

The electric lighting plant is located on a level with the middle platform in a recess aft of the main engine room. It consists of three General Electric Company's direct connected generators of 25 Kw. capacity each. The engines are compound, 6 1-2 and 10 1-2 inches by 7-inch stroke, and run at 400 revolutions. The generators are D. C. compound wound for pressure of 110 volts. The switchboard has the usual complete equipment of voltmeter, ammeters, ground detectors, circuit breakers, etc. There are over 900 lamps of 16 c. p. each.

The refrigerating plant is located below, aft of the main engine room in the space between the main shafts. The machine is built by the J. & E. Hall Company of England, and uses carbonic anhydride gas. The engine is cross compound, cylinders 11 and 22 inches with 15 inches stroke. The compression cylinders are of wrought steel, arranged in tandum with the steam cylinders. The bed plate of the machine is made large so as to incorporate the necessary auxiliaries. It contains the condenser for its own engine, also two condensers for the CO_2. The attached pumps consist of air pump for the engine condenser, feed pump to deliver discharge of same to feed tank, and circulating pump to supply cooling water for the condensers. An independent duplex pump 4 3-4 and 6 1-2 by 6 inches is also fitted for circulating the condensers when required.

The two evaporators for the refrigerating gas are located aft of the machine. The cold brine from these is circulated through the chambers by two vertical duplex 4 3-4 and 6 1-2 by 6-inch pumps. A complete distributing system of manifolds, with thermometers, allows the operation of the cold storage plant in any way desirable. The total refrigerated space is about 9,000 cubic feet. There is also an ice-making plant arranged for 20 cans of about 28 pounds each.



LAUNCHING OF THE STEAMSHIP MONGOLIA FROM THE COVERED SLIP AT THE NEW YORK SHIPBUILDING COMPANY.

A very completely-equipped machine shop is located on the upper deck abreast of the engine room on the port side. The machinery equipment consists of the following tools arranged to be driven by a vertical 6 1-2 by 7-inch New York Safety Power Company engine: 1 Kelly 16-inch shaping machine, 1 Barnes 25-inch drill press, 1 Slater sensitive drill, 1 double heavy emery wheel grinder, 1 16-inch back-geared screw-cutting lathe 14 feet between centers, 1 Forbes adjustable pipe-threading machine, 1 24-inch grindstone. The tool rooms are located on the middle deck abreast of the engine room.

BOILERS.

There are eight main boilers, Scotch return tubular type, built for a working pressure of 215 pounds. Four are double end, 19 feet, 4 5-8 inches long between heads, 14 feet 5 inches mean diameter, and four are single end, 10 feet 10 1-2 inches long between heads, of same diameter. The heating surface of the double-end boilers is 4,702 square feet each, and the single-end 2,367 square feet. The double-end ones have six furnaces 40 1-2 inches inside diameter, with a grate surface of 106 square feet, and the single-enders three furnaces, with 53 square feet grate surface.

The double-end boilers are located abreast of each other, just forward of the cross bunker that extends between engine and boiler rooms; the single ends are similarly arranged forward of these, facing them so the same fire-room serves for the forward end of double-enders and after end of single-enders. Chutes run from upper side bunkers to each side of the double fire-room. Another cross bunker extends across the ship forward of the boiler compartment, and a trolley service transports the coal from both the cross bunkers to fire-rooms.

A small auxiliaray boiler is located on the middle deck aft of the after fire-room hatch. It is single end, return tubular, of the dry-back type, 5 feet 6 inches diameter, 7 feet 4 inches between heads. The pressure is 215 pounds.

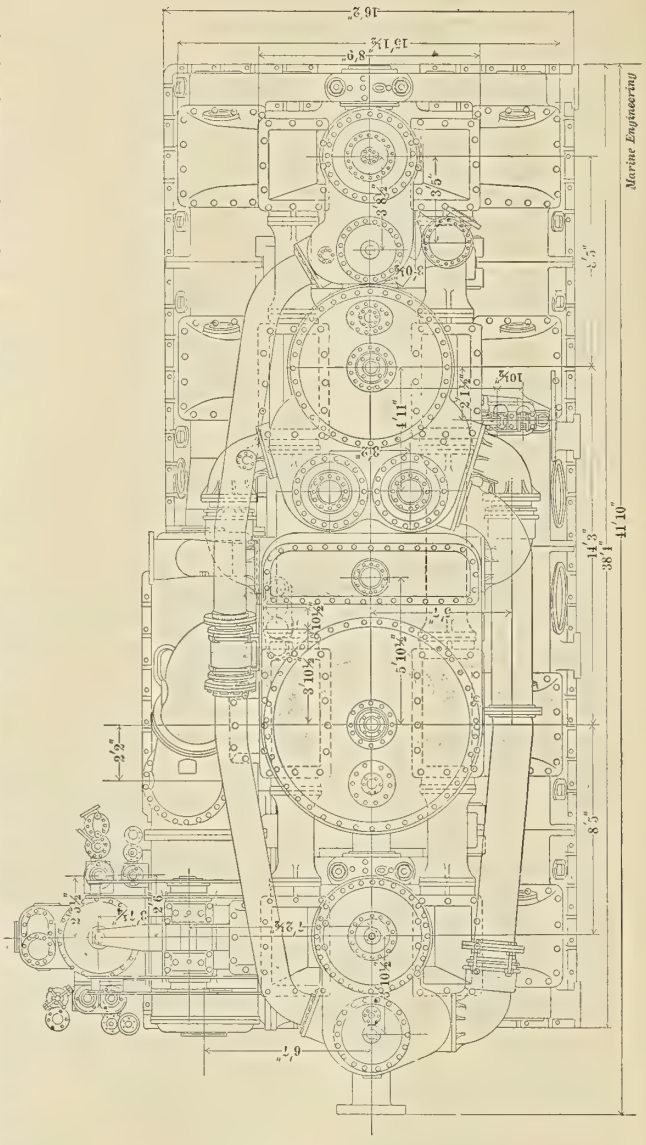
The main boilers are fitted with the New York Shipbuilding Company's heated forced draft. The results of the trial show this system to be very efficient and satisfactory. At no time was there any trouble in maintaining full boiler pressure for the maximum steam demand made by the engines. This was done with an air pressure of 1 inch in the ash pits. There are three Sturtevant blowers, 96 inches diameter, driven by double engines 8 1-4 by 5 1-2 inches stroke. One is located over each fire-room hatch on the grating below the shelter deck. Air is drawn from over the boilers and heated in the usual vertical tube heaters in the uptakes before being admitted to the furnaces. The uptakes all unite in a common smoke pipe of elliptical section, 10 feet 9 inches wide and 14 feet 3 inches fore and aft.

There is an 84-inch Sturtevant fan with 6 by 5-inch double engines provided for ventilating the fire rooms. The ash hoists are steam, of the direct lifting type. Large ash chutes are conveniently located inboard with continuous flushing arrangement.

The steam piping systems are carefully arranged and very complete, provision being made for overhauling without shutting down necessary auxiliaries, such as dynamoes. All the distributing systems can be operated from the manifolds in the engine room at the forward bulkhead. A reduced pressure of 100 pounds is used for all auxiliaries except main feed pumps.

DECK MACHIINERY.

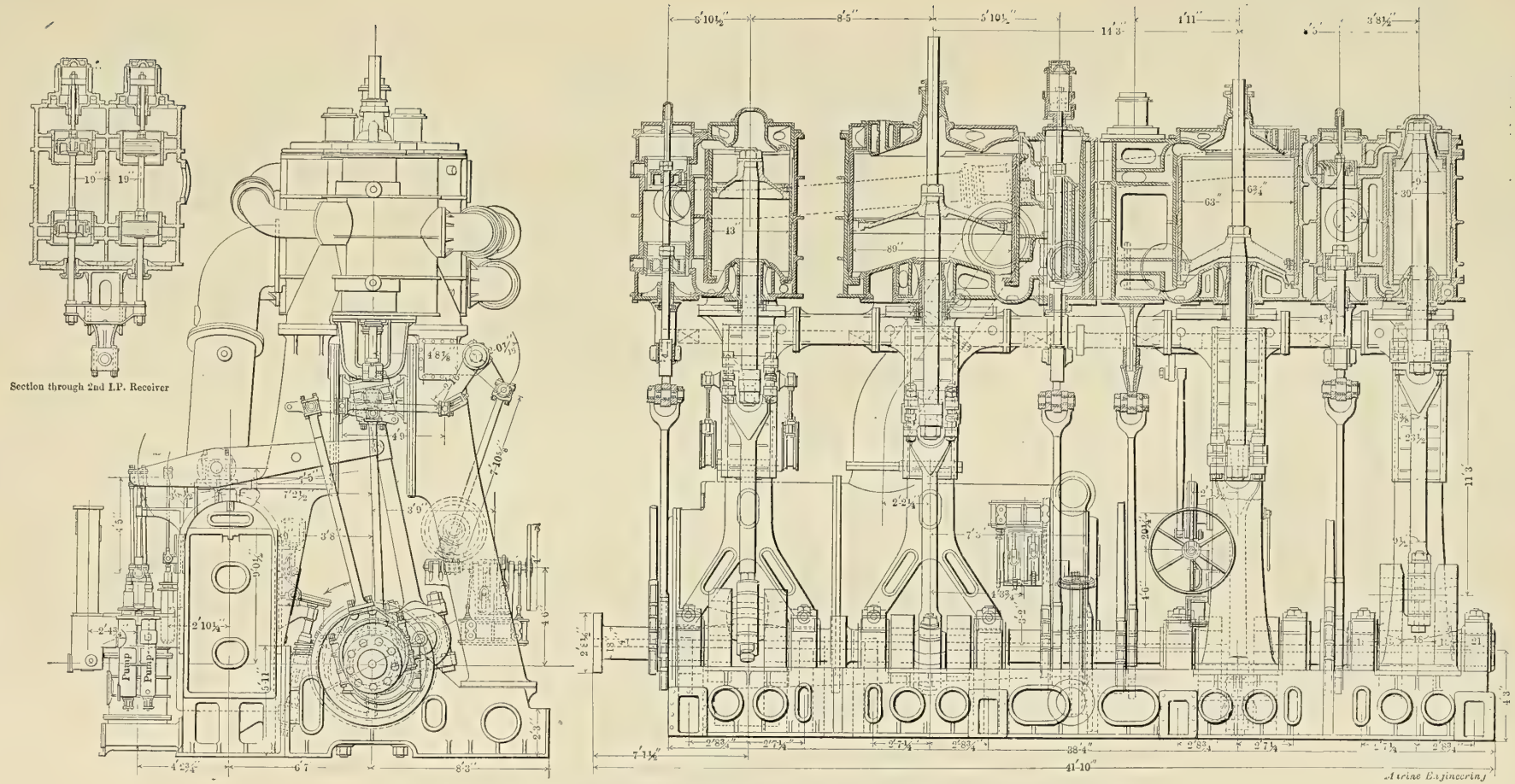
There are 19 winches of the horizontal double engine type, built by the Hyde-Windlass Company. Two each, with engines 8 by 14 inches are located at all hatches up to No. 9, while No. 10 has one with engines 10 by 16 inches. All these are fitted with gypsy heads, drums,



and change gearing as required for the service intended.

The anchor windlass engines are located on the upper deck. They are vertical, 18 by 14 inches, also of the Hyde type. The windlass is located on the shelter deck and receives its motion from the engines through bevel and worm gearing. It is extremely massive and strong to suit the requirements of so large a ship.

The steering engines are located aft in the deck house provided for same. They are built by the Williamson Brothers from type used by Harlan & Wolff. There are two complete double vertical engines mounted on sliding beds, so arranged that either may be brought into or thrown out of gear as desired. This is accomplished by means of adjusting screws which move the whole engine bed, the steam pipe being run in circular loops to admit the necessary movement. Each engine is double, 13 by 14 inches, with piston valves, and the usual arrangement of floating change valve to control movement. The engines are connected to the rudder quadrant by means of bevel gears between the horizontal



THE PORT SET OF THE FOUR-CYLINDER TRIPLE EXPANSION ENGINES FOR THE STEAMSHIP MONGOLIA.

and vertical auxiliary shafts for each engine. The gearing and all other parts are of ample weight and strength. The quadrant connects to the tiller proper through heavy coil springs which take up jar. The reversing valve of the steering engine is controlled from the bridge through shafting and bevel gearing. They can also be controlled from the after bridge or engines direct. No hand steering gear is provided, but a spare tiller is fitted and arranged for tackle connection with the after winch.

Ample provision is made everywhere for sanitation and ventilation. There is a Clayton fire-extinguishing and fumigating apparatus on the upper deck aft of the engine room. It consists of a gas generator and direct connected blower and engine with the necessary pipe connection to the holds and compartments. This can be used to send gas for either purpose anywhere throughout the ship.

Strength of Our Navy.

Mr. Hale, chairman of the Senate Naval Committee, gave some interesting figures on the strength of the United States Navy, when the Navy appropriation bill was under discussion in the Senate on March 3. The present bill, which provides for the construction of one 16,000-ton battleship, two armored cruisers, three fast scout ships, and two colliers, calls for an expenditure of $97,001,738.94.

The total provision for increase of the Navy in 1883 was 13,000 tons, less than a modern battleship. From that time appropriations had been made year by year, providing for cruisers and first-class battleships, down to 1900.

"We have appropriated since 1884 for the new Navy $760,896,567.75," said Mr. Hale. "As showing the growth of the navy in another respect, I have the list of men and petty officers. In 1883 the Navy consisted of 8,250 men and petty officers. We now have 34,000. The pay of the Navy in 1883 was $6,940,780, and last year it was $19,824,083." He then gave a summary of all vessels in the Navy fit for service, 254 in all, and 43 others under construction or authorized. Twenty-three vessels, in addition were unfit for service. The total tonnage of the Navy in service is 531,886. The tonnage under construction is 394,431, making a total of 881.317, tons, of 1,248,386 horse power, requiring 45,881 men.

In reply to a question Mr. Hale said that United States was ahead of Germany, not counting vessels under construction; that many obsolete vessels were carried in foreign navy lists as available and effective tonnage, while this was not done in our Navy. The offensive fighting ships of the United States as compared with similar ships abroad placed the American navy, in his opinion, next to that of England alone. "When the programme is completed," he added, "the United States will be way beyond France, or Germany, or Russia, or Japan, and much nearer Great Britain than anybody realizes who has not studied these figures."

Mr. Hale remarked that it was surprising how soon naval boards retired useful vessels from the offensive line and placed them on the list of defensive vessels. "The Navy Department is already talking of placing the *Oregon, Massachusetts* and *Indiana* on the retired list as harbor defence vessels. Nothing suits the Navy officers but the very largest and finest ships. There is not on the seas a single battleship of 16,000 tons, yet we are building nothing else."

Erata.—In the drawing illustrating "Electricity on Shipboard," page 73, February, 1904, the left hand connection of switch *B* should be to the top line, running from left to right instead of to the third line, as shown.

MARINE ENGINEERING DATA CARD. **APRIL, 1904.**

NAME—Mongolia and Manchuria. NATIONALITY—American. TYPE—Ocean passenger and freight.
LAUNCHED—1903. BUILDER—New York Shipbuilding Co. OWNER—Pacific Mail Steamship Co.

Length over all.....615 ft. 8 in.
" between perps.....600 " 0 "
Breadth, molded.....65 " 0 ".
Depth, molded to upper deck.....43 " 3 "
" to shelter deck.....51 " 3 "
Draft, load.....33 " 6 "
Displacement, load.....26,514 tons
" launching, includ g cradle. 9,487 "
Gross tons.....13,636 "
Block coefficient, about.....69
Water ballast, double bottom.....2,270 tons
" three deep tanks.....2,330 "
Coal bunker capacity, normal.....1,950 tons
Total capacity.....4,750 "
Speed, sea, load draft.....15 knots

Engines: Number.....2
Cylinders, diameters.....30, 43, 63, and 89 ins.
Type.....four-cylinder, quadruple
Valves, piston except L. P.; Stephenson gear.
Stroke.....60 in.
I. H. P., at sea.....10,000
Revolutions at sea.....80
Shafting: Crank, diameter.....18 in., 4-in. hole
Line, diameter.....17 1-8 " 6-in. "
Thrust, " ..28 1-4 and 17 3-4 " 6-in. "
Propeller, mean.....18 1-4 " 6-in. "
Cooling surface, each engine, 7,500 sq. ft.
Air pump, direct-connected, diameter, 30 1-2 in.

MARINE ENGINEERING DATA CARD. **APRIL, 1904.**

NAME—Mongolia and Manchuria. NATIONALITY—American. TYPE—Ocean passenger and freight.
LAUNCHED—1903. BUILDER—New York Shipbuilding Co. OWNER—Pacific Mail Steamship Co.

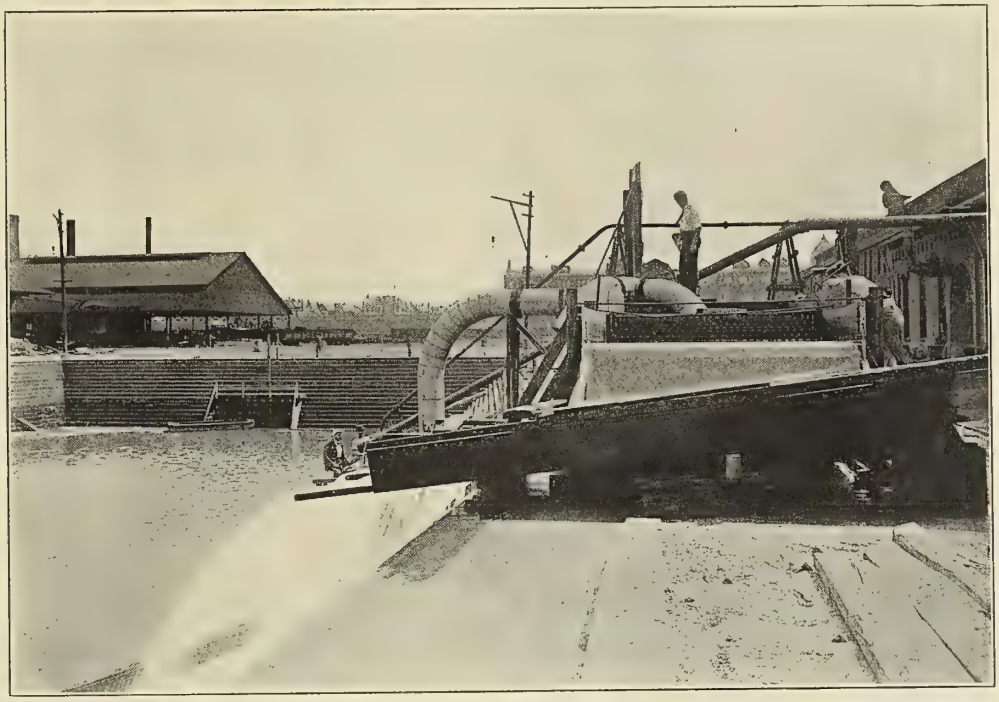
Propellers: Number.....Two 3 blades each
Diameter.....18 ft. 6 in.
Pitch.....23 " 6 "
Helicoidal area, each wheel.....86.6 sq. ft.
Boilers: Working pressure.....215 lbs.
Scotch, 4 single-end, 4 double-end
Diam., mean, 14 ft. 5 ins.
Length, 10 ft. 10 1-2 in., 19 ft. 4 5-8 in.
Tubes, diam., 2 1-2 ins.
" number, 410 820
" length over all, 7 ft. 6 1-2 in., 7 ft. 10 1-8 in.
Thickness, stay tubes, 1-4 in.; plain, No. 8 B. W. G.
Furnaces: Inside diam. 40 1-2 in.
Number, each 3 single-end, 6 double-end
Length of grates 5 ft. 3 in.
Heated forced draft
H. S., each 2,367 sq. ft., 4,702 sq. ft.
Total, 28,276 sq. ft.
G. S., each 53 sq. ft. 106 sq. ft.
Total, 1,036 sq. ft.
H. S. ÷ G. S., 44.5
I. H. P. ÷ G. S., 15.75
H. S. ÷ I. H. P., 2.8

Test of Centrifugal Pump.

BY P. P. BIRD.

To measure the discharge of a centrifugal pump discharging 15,000 gallons of water per minute, presents some difficulties to the engineer which may properly be discussed here. The following description and pictures illustrate the methods recently used in testing a pump for the armored cruiser *West Virginia,* at the yard of the Newport News Shipbuilding & Dry Dock Company, at Newport News, Virginia.

The centrifugal pumps, as installed in the engine rooms of a modern warship, have as their primary object the circulation of cooling water through the condensers. However, they are also arranged so that their suctions



ARRANGEMENT FOR CAPACITY TEST OF CENTRIFUGAL PUMP FOR CRUISER WEST VIRGINIA. RUNNING AT MINIMUM DISCHARGE.

are connected to the drainage system of the ship, and also to the bilge at that point. Further, the specifications for the *West Virginia* class state that each pump shall be capable of discharging overboard a certain number of gallons of water per minute from the lowest point of the bilge suction. They further state that "the pumps will be tested by discharging water under conditions as nearly as possible like those they will be working under when throwing water from the bilges. They must discharge water at the same height as the water line is above the pumps and through the same length and size of pipe, drawing water from the same depth as the lowest part of the bilge suction pipe below the pump and through the same length and size of pipe."

In the case of the pump above referred to the specifications required a discharge of 15,000 gallons of water per minute, the revolutions for such outfit not exceeding 266 per minute.

Previous experience had shown the difficulty of testing a pump of this sort with its suction within the influence of the tide. As with the pump on the pier the continually changing suction head seriously interferred with the uniformity of testing. Also with the pump mounted on a float, the immense weight of water in the system would result in not only considerably shortening the lift of the pump, but in giving the float a bad list, unless previously provided for. Further, when testing a pump on the pier or on a float, it had been found difficult to get good steam or vaccum to approximate the conditions obtainable aboard ship. A pump of this kind when in service conditions, of course, is below the water line, and being always immersed, will start without priming. However, when located above the water line, it is necessary to run the pump very fast, considerably above the normal speed, for some minutes before it will "take hold" of the water and pump. This means using an immense quantity of steam before actually starting the test, enough to empty a small portable boiler, such as would be found available around the piers.

The above difficulties made it desirable to locate the pump for testing in such a way as to maintain practically uniform conditions as to heads throughout the test, and also to get the pump near a good supply of steam, and if possible where the engine could be connected to a condenser.

Fortunately there was at the disposal of those making this test a dry dock with a power house located close at hand. Accordingly the pump was installed on the slope of the dry dock at a point near the steam and vaccum supply.

Three methods of measuring the water discharged were considered:—

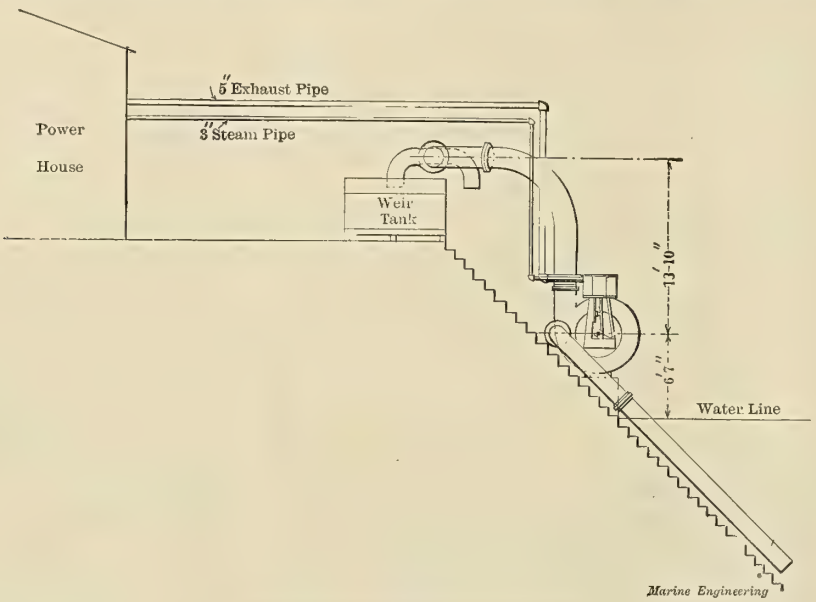
1st. By measuring the velocity of flow in the discharge pipe. This could be done in several ways, *i. e.,* by means of a small propeller wheel placed in the pipe and assuming a slip, or by Venturi meter, or by Pitot's tube.

2d. By pumping a known quantity of water, enough to fill a dry dock for instance, and

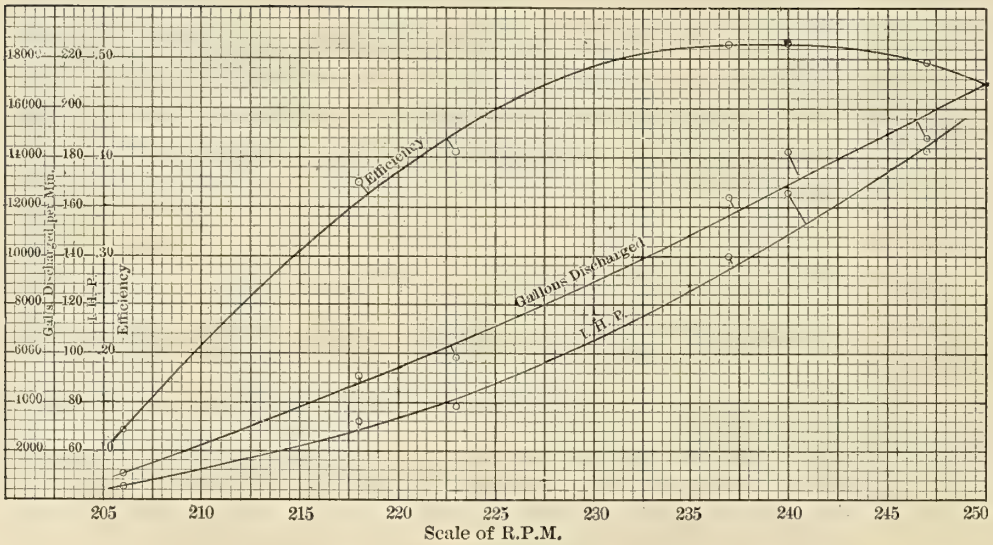
3d. By pumping into a tank and discharging from this over a weir.

The latter method had been successfully used before with a smaller pump and was adopted in this case. As it was desirable to use the tank which had been made for the previous test and as this tank was too small to charge head when pumping into the tank, which was placed alongside the dock on the ground level.

By referring to the arrangement drawings, the vertical distance from the center of the pump, as to be installed on ship, to the water line at trial displacement, was found to be 13 feet 10 inches. This gave the necessary discharge head and in the test was the vertical distance from the center of the pump to the highest point in the



PIPE PLAN FOR CENTRIFUGAL PUMP TEST.



CURVES OF CAPACITY, HORSE POWER AND EFFICIENCY FOR CENTRIFUGAL PUMP TEST.

take the full discharge of this large pump, the 21-inch discharge pipe was divided into two 15-inch pipes—one only of which discharged into the tank, it being assumed that the discharge was equally divided, and that the observed readings on the weir would indicate half the total discharge.

The pump was located for the test at a point far enough down in the dry dock to give the proper discharge pipe. The length of this pipe was made 31 feet, which was equal to the total length of the system discharged through aboard ship, from the flange on the pump to the skin of the ship.

Similarly from the drawings the vertical distance from the center of the pump to the bottom of the nozzle of valve in main drainage line in the engine room was found to be 6 feet 7 inches. This gave the necessary lift

of the pump—accordingly, the dry dock was flooded to a point this distance below the pump. The two 15 1-2 inch suction pipes were run down in the dock some distance below the water level—so as to give the same length of pipe as used aboard ship. This was found from the drawings to be 31 feet 3 inches.

All of the water pumped drained back into the dry dock, so the conditions were constant throughout the trial.

The pump was driven by a direct connected vertical compound engine, the diameter of the high pressure cylinder being 11 inches, the diameter of the low pressure cylinder 22 inches and the stroke 10 inches.

The cranks were at right angles to each other. Steam is admitted to the high pressure cylinder by a piston valve, and to the low pressure cylinder by a slide valve. The steam pipe running from the power house was 3 inches in diameter and the exhaust pipe 5 inches in diameter.

The diameter of the pump fan was 45 inches and the width at periphery was 4 inches. There were six valves.

ENGINE DATA.

No.	Time.	Steam Press.	Vacuum	R.P.M.	M.E.P.		I.H.P.		Total I.H.P.	M.E.P. to Low.
					H.P.	L.P.	H.P.	L.P.		
1	10-25	112	18½	206	20.83	6.50	20 2	25.6	45.8	11 60
2	10-40	113	17½	218	34.13	8 88	34 95	36.95	71.9	17.20
3	10 35	113	17½	223	36 65	9 66	38 4	41.1	79.5	18.60
4	10-40	112	15½	237	57.50	16.82	64 0	76.1	140.1	30.80
5	10 48	113	15	240	61.05	21.20	68 9	97.1	166.0	36.10
6	10-57	118	15	247	65 50	22 73	75 6	107.1	183 1	38.65

During Card No. 6 the bypass valve was open, admitting live steam to the receiver.

WEIR DATA.

Time.	Head on Weir.	Cu. ft. over weir per Sec.	Cu. ft Discharge by Pump per Sec.	Gallons Discharged per Min.	Velocity of Discharge.	Velocity Head.	Total Head.	Water H. P.	I. H. P.	Eff.
10-25	1.5″	1.18	2.36	1 060	Small neglect	0	20.42	5.61	45.8	12.24
10-30	4.25	5.62	11.24	5 044	4.68	.34	20 76	27.1	71.9	37.7
10-35	4.75	6.61	13.22	5,940	5.50	.47	20.88	32.1	79.5	40.4
10-40	7.75	13.82	27.64	12,420	11.50	2.05	22.47	72.2	140.1	51.5
10-48	8.50	15.90	31.80	14,270	13.22	2.72	23.13	85.5	166.0	51.5
10-57	8.75	16.60	33.20	14 900	13.78	2.95	23.56	90.3	183.1	49.35

By referring to the above data it will be seen that the highest revolutions obtained were 247 at a steam pressure of 118 pounds per square inch. The working steam pressure for the engine aboard ship will be 150 pounds per square inch. At 247 revolutions per minute 14,900 gallons of water were pumped. The curve of revolutions and discharge shows that the pump was of ample size to meet the requirements.

The Francis formula which was used in figuring the weir discharge is

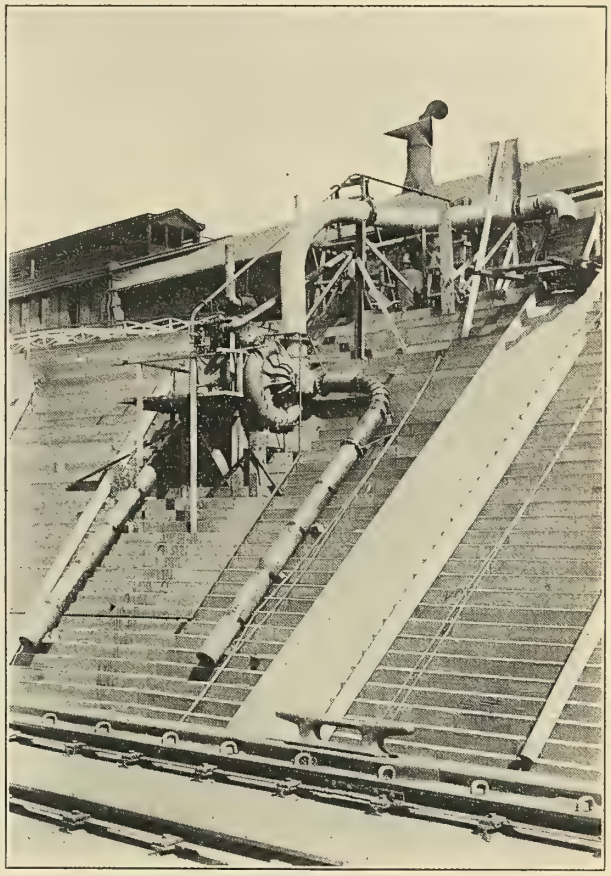
$$Q = 3.33\ L\ H^{\frac{3}{2}}$$

Where Q is the discharge in cubic feet per second.
L is the length of weir in feet, equal to 8 in this case.
H is the observed head over weir in feet.
No correction was made for the velocity of approach. Of course this would have been in favor of the pump. The velocity formulas are:

$$\text{Velocity of discharge} = \frac{\text{Pump discharge in cu. ft. per sec.}}{\text{Area of discharge in sq. ft.}}$$

$$\text{Velocity head} = \frac{(\text{Velocity of Discharge})^2}{64.4}$$

The constant static head was 6 feet 7 inches lift plus 13 feet 10 inches discharge, equal to 20 feet 5 inches. The total head in each case was the velocity head plus the constant static head. The head due to friction was neglected as the pipes were so short.



VIEW OF THE PUMP, SUCTION AND DISCHARGE PIPES.

$$\text{Water horse power} = \frac{(\text{Gals. per min.}) \times (\text{total head}) \times 8.54}{33{,}000}$$

$$\text{Efficiency} = \frac{\text{Water horse power}}{\text{Indicated horse power.}}$$

An attempt was made to measure the velocity of discharge by inserting a Pitot tube in the 21-inch discharge pipe. The values of the discharge corresponding to the velocities obtained in this way were slightly in excess of those obtained from the weir measurements. This was to be expected as no correction had been made for the velocity of approach to the weir.

The pipes used in the test were made of riveted sheet steel and all seams in the suction pipes carefully calked.

English Shipbuilding Notes.

The number of shipbuilding contracts recently placed, principally with builders on the north-east coast of England, has been matter for surprise in view of the very considerable depression in the shipping trade and the lowness of freights. One reason given is the very exceptionally low prices which have been accepted. Some of the vessels of about 6,000 tons dead-weight carrying capacity having been contracted for at the rate of £.12.6 per ton. Very long terms too are being accepted by some of the shipbuilders for payment for these ships. It has long been the practice for firms to accept bills, payable a year or so after the completion of the ship, but in some of the recent cases the payments are to extend over 7 and even 10 years after completion. This is a dangerous element which ought to be checked, as speculative shipowners will be encouraged to enter the market, not so much to supply their legitimate needs as to enable them to conduct a brokers business and in this way it is possible that the future may be very heavily mortgaged for the present, whereby a legitimate recovery of sound business would be materially postponed. Other dangers are almost self-evident, so that it is not necessary to point to them.

Lloyd's register of shipping has just issued an interesting return showing the balance sheet of British mercantile tonnage and from this it is seen that the fleet now numbers 20,464 vessels of 15,773,981 tons. The gain in ten years is about 27 per cent. The number of sailing vessels has very considerably decreased, while the number of steamers has increased and at the same time the carrying capacity of the average ship has greatly developed. The British merchant marine, it is therefore accepted, increases at the rate of 5 per cent. per annum. One remarkable fact is that the new vessels account for a much greater increase than this 5 per cent., and the explanation is to be found in the circumstance that foreigners buy each year a large proportion of more or less obsolete tonnage. Thus during the past year 300,574 tons were sold to foreigners, and of these 34 per cent. were vessels built prior to 1880, 59 per cent. prior to 1885 and 71 per cent. prior to 1890. The fact that such old vessels in the hands of foreign owners compete with British ships has again given rise to the contention that shipping legislation applicable in British harbors to vessels owned by that country militates against their successful competition, and a plea is again being put forward that Parliament should amend in some measure this unequal condition. The president of the Board of Trade, in whom is vested such matters, has been invited by a deputation of owners to apply the restrictions as to loadline and free-board to foreign ships engaged in the British trade as well as to ships flying the Union Jack, and it is very probable that this one of the most important disabilities under which English ships work in competition with foreigners will be removed.

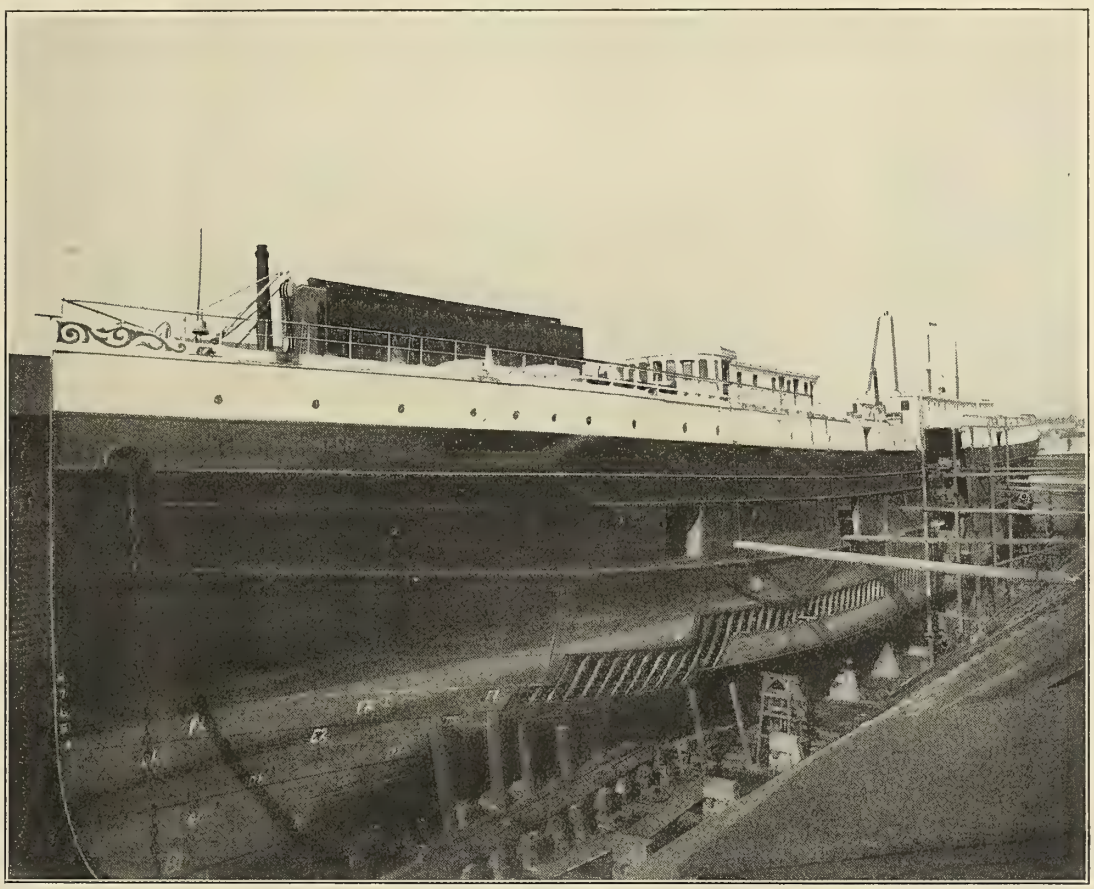
The Institution of Naval Architects which meets towards the end of March is now arranging its programme, and it is anticipated that there will be a "battle royal" between those two giants in the profession, Sir William H. White and Sir Edward J. Reed. The former, it will be remembered, succeeded the latter at the Admiralty, and Sir Edward Reed has since designed many ships for foreign navies, principally those of the South American republics. In these vessels it is claimed he succeeded in introducing a greater gun power, if not also a higher speed, than is the case with the British ships designed by Sir William White. The latest of Sir Edward's ships—the two Chilian battleships recently bought by the British Government—are to form the subject of a paper to be read by him at the forthcoming meeting and as already both the naval architects named have had a "an affair of outposts," so to speak, in the public press, Sir Edward Reed's comparison of the Chilian ships with those of British design is certain to give rise to a lively, if somewhat inconclusive, discussion.

Considerable interest is being taken amongst the profession in the various visits to be paid to America during this year in connection, principally, with the St. Louis Exhibition. Neither the Institution of Marine Engineers, nor the Institution of Naval Architects will meet in America, but many of the members will visit the States along with other institutions. The first visit to be paid will be that of the Institution of Mechanical Engineers who are to meet at Chicago in the first days of June along with the American Society; already over 200 British members have signified their intention of being present and while no official visit will be paid to the Exhibition, many of the members will go there and with personal introductions from the Secretary of the American Society, Professor Hutton, they will visit many works. The Institution of Civil Engineers arrive in New York early in September. No meetings for the reading of papers will be held, but the Institution will pay a visit of courtesy to the American Society at New York. The Iron and Steel Institute will hold their meetings at New York on October 24th, 25th and 26th, and already between six and seven hundred have promised to attend. The fact that Mr. Andrew Carnegie is this year the president will further invest the proceedings with interest. The British Society of Chemical Industry will meet at New York on the 8th of September, and the Société des Ingenieurs Civils de France leave Havre on the 20th of August. Like the members of the institution of Civil Engineers those of the French Society will travel together in one steamer, whereas the members of other Institutions will proceed to New York as they choose.

It is worth noting that the first naval power to suffer from torpedoes in modern warfare, viz., the Russians, was the first to have made some effort to protect its ships by armor against torpedo attack, but unfortunately none of the ships in which this protection has been incorporated are yet ready. The five vessels of the *Borodino* class, now being completed in the Baltic, have their broadside protected with hardened nickel steel 1 1-2 inches thick, from the bottom of the main belt to near the turn of the bilge, with a view to minimising to some extent the effect of the explosion of the charge of the torpedo. The main belt is nine inches thick, tapering to 6 inches thick at the ends, with an auxiliary belt above that of 4 inches. It is a pity that these ships were not ready so that the efficiency of this light armor might have been tested in actual warfare.

Lengthening the Steamer Decatur H. Miller.

A naval architect is called upon to solve many unusual problems, but probably the most interesting is that of lengthening a steamer. With the increased efficiency of the modern ship over her old-time sister, and the decreased freight rates, it is generally the rule that the old ships are scarcely able to be run in competition on any profit to the owners. In such cases it is frequently found that by lengthening a steamer and increasing her carrying capacity, the ship will be good for several more years of profitable service. The first consideration, of course, is whether the condition of the hull is such that it will last long enough to warrant the expense of lengthening.



STEAMER DECATUR H. MILLER AFTER SHE WAS CUT IN TWO FOR LENGTHENING.

There has just been completed by the Maryland Steel Company, Sparrows Point, Md., the lengthening of the steamer *Decatur H. Miller,* one of the fleet of the Merchants and Miners Transportation Company. This ship was built of iron in 1879 at the Harlan & Hollingsworth Company, Wilmington, Del., at a time when iron and not steel was used in ship construction. The registered dimensions of the old ship were: Length, 250 feet; beam, 38 feet 6 inches; depth, 25 feet 3 inches; and net tonnage, 1,675 tons. The present dimensions of the vessel are the same, excepting that the length is 280 feet.

The *Miller* arrived at the yards of the Maryland Steel Company on November 23, 1903, and a force of men was immediately put to work taking off fittings, stack, up-take, etc., and the boilers were lifted on December 3. Four days later the ship was towed to the yard of the Baltimore Shipbuilding and Dry Dock Company, to which company the contract for docking work had been sublet. On December 9 the ship was floated into a dock and as soon as dry was attacked by a force of workmen, who commenced cutting out rivets in shell, deck, keelsons, and so forth. To such good effect was this work accomplished that notwithstanding the handicap of bad weather, all preparations were completed and everything ship-shape for pulling the bow, on December 19.

The power for this was supplied by four hand windlasses, well fastened to piles at head of dock, and each manned by sixteen men. From these windlasses the lines led to tackles of 14-inch treble blocks. Two of these were connected, one on each side, to the anchor chains, and two at forward cargo ports. The latter were made fast to heavy chains rove through the forward ports and along the side of ship and back again through another pair of cargo ports further aft. A fifth tackle was made fast to a forged shackle with bolt through the stern near the line of keel. The hauling part of this tackle was taken by a yard crane. The ground and sliding ways were of ample size and a stop was placed 30 feet from the starting point. When all

was in readiness, the winches were started and the fore body was pulled to the head of the dock. So well managed was the operation that the bow portion was brought to rest when the sliding ways were within one-eighth of an inch of stop. The time from start to stop was 37 minutes. It having been observed that in cutting apart, the bow had drooped slightly, the ways were arranged on a gradual incline, which corrected this and made it possible to obtain a fair sheer line. Test lines were run as soon as the ship was at rest, and the only difference perceptible was a spreading of the after part of the bow portion (through the woodwork), amounting to one-eighth of an inch. Sights were arranged before pulling, but on trying these afterwards it was impossible to perceive any variation.

Work was soon under way towards closing up the big gap made, and on February 9 water was admitted to the dock and the *Miller* taken out, 30 feet longer than when she entered.

When entering the dock marks were placed on the bow and stern at water-line, and measurements made when floated, the ship after lengthening showed a decrease in draft of 12 inches forward and 6 inches aft, due to the added length.

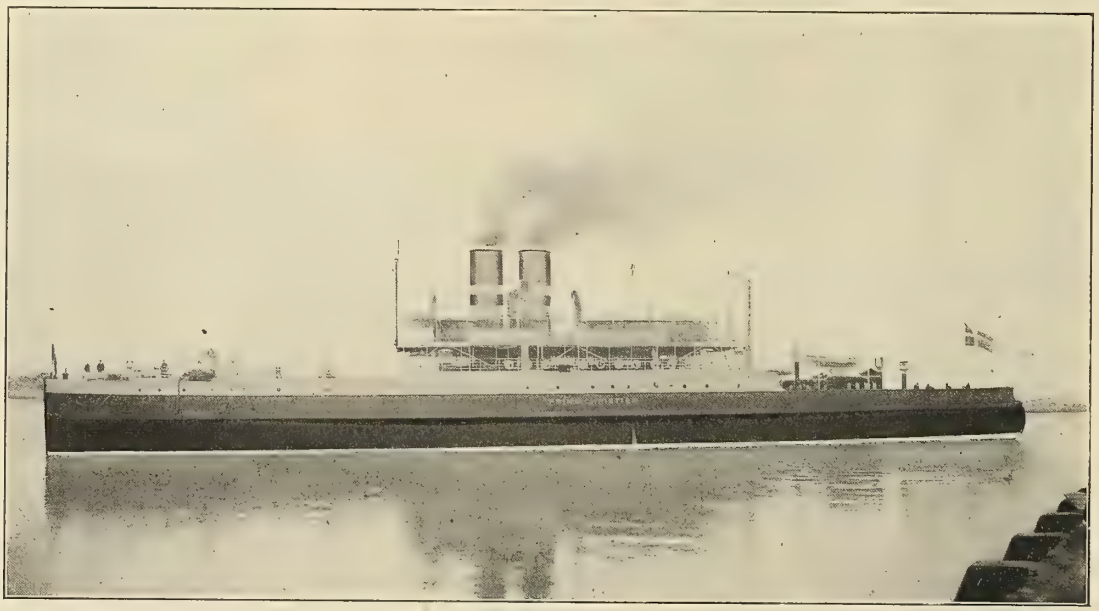
In addition to the new material occasioned by the extra length, there were 88 plates taken off and replaced, bilge keels 80 feet long fitted, and two new cargo ports cut.

The ship has since been towed to the yards of Maryland Steel Company, where the ship-carpentry, joinery, plumbing, piping, and so forth, will be arranged in the new section, and four new boilers installed, together with new cylinders for main engine and sundry repairs to same.

Mr. Thomas M. Cornbrooks, naval architect, has superintended the repairs as representative of the builders, and Mr. John M. Blankenship as representative of the Merchants and Miners Transportation Company.

THE DANISH STEAM CAR FERRY PRINS CHRISTIAN.

The ferryboat *Prins Christian* was recently built at Elsinore, Denmark, by the Helsingor Iron Shipbuilding and Engineering Company, Ltd., for the traffic between Gjedser, Denmark, and Warremunde, Germany. She was ordered by the Danish governmental railroad to complete the newly projected direct route between Berlin and Copenhagen, which heretofore has been very tedious, owing to the transfer from the trains to small boats and to the frequently encountered heavy weather. The vessel was delivered about the middle of September, having been built in about twenty months. She is the largest ferry ever built in Denmark, and is the most valuable vessel turned out from the yard at Elsinore. Her over-all dimensions are 285 feet by 56 feet. She is supplied with twin screws worked by two sets of triple expansion engines, developing 2,600 I. H. P. On the trial a speed of upwards of 14 knots was obtained.

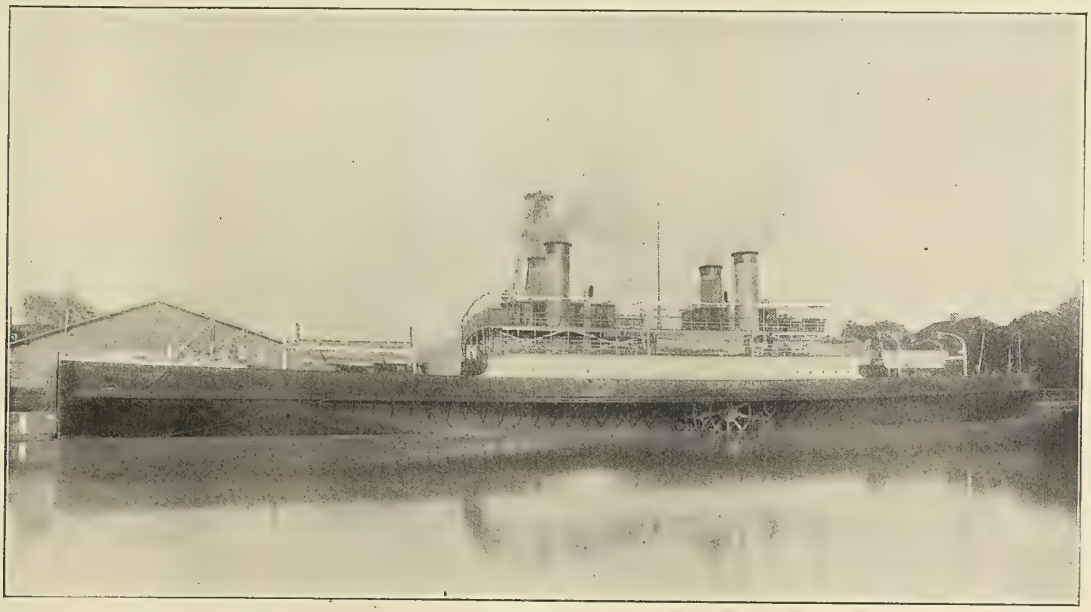


DANISH TWIN SCREW CAR FERRY PRINS CHRISTIAN FOR SERVICE ON THE BALTIC.

Everything has been done to study the comfort and accommodation of the passengers while on board this steamer. As the Baltic is frequently quite rough, the *Prins Christian* is furnished with very large bilge keels, which, together with some large balance tanks, tend to minimize rolling at sea. To effect shelter on deck, the bulwarks forward are built up to about 9 feet high, and above this a promenade deck is fitted amidships at a height of 16 feet above main deck. The general arrangement can be seen in the accompanying plans. A specially novel feature is the large port at the bow through which the cars pass. The entire bulwarks at the bow form a swinging port with axis thwartship, and operated by special machinery. When closed, the ports give the vessel the appearance of being built with a forecastle.

Two railway tracks are laid from end to end for the railway cars; at the ends these tracks converge to meet the corresponding tracks on the pier. From the cars

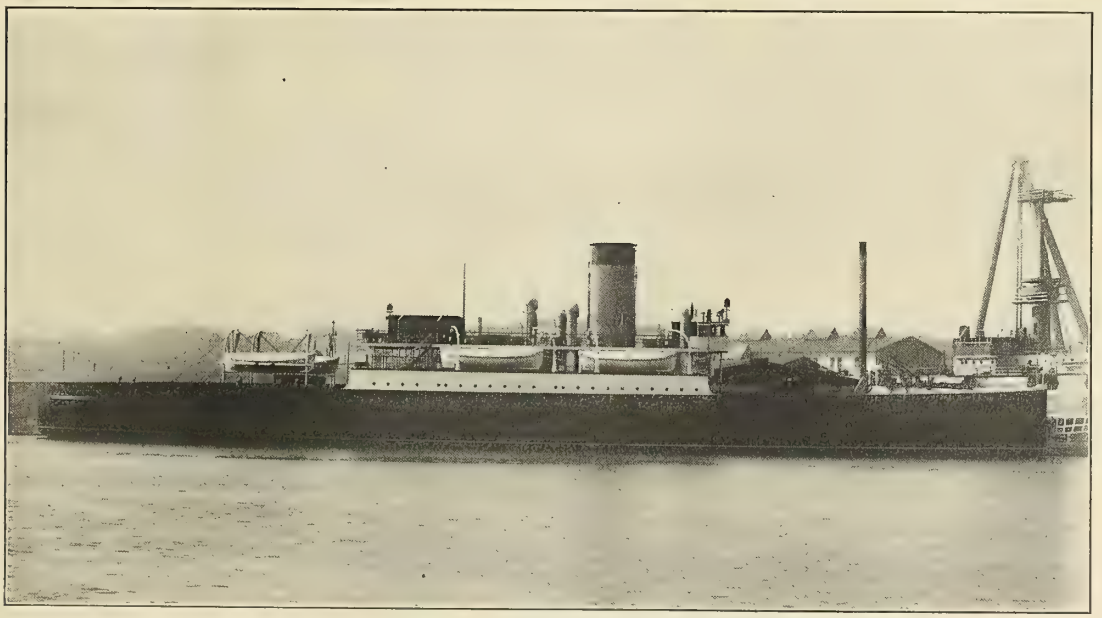
the passenger steps upon platforms in front of the main deck houses. These houses are built at the sides as in the older ferryboats, affording room for part of the crew, and the postal and railway clerks. Here, too, are



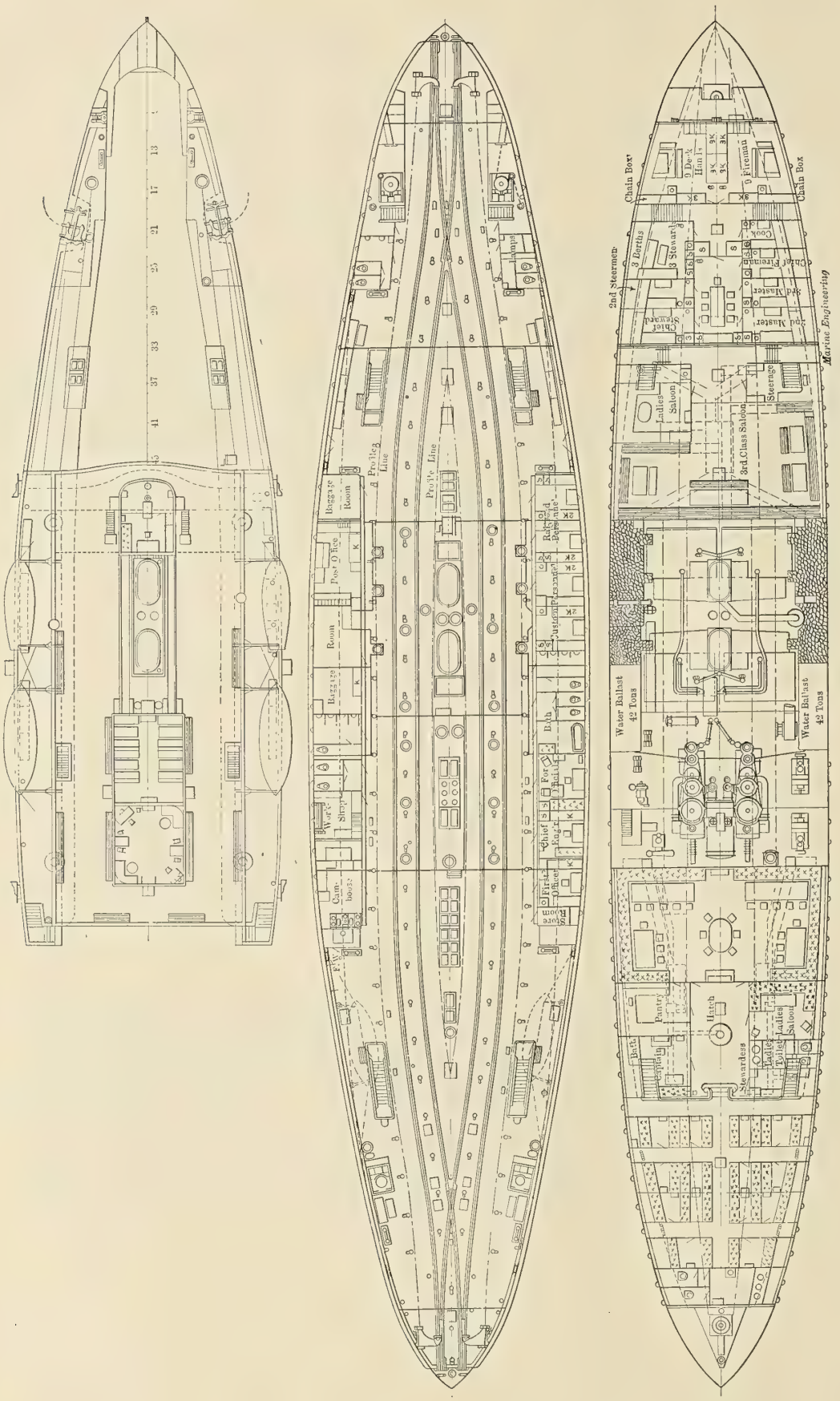
DANISH PADDLE WHEEL CAR FERRY PRINSESSE ALEXANDRINE.

workshop, post-office, toilet rooms, kitchen, and a private suite of rooms for officials. The cabin for the latter is furnished with white japanned walls, gilt mouldings and furniture of mahogany, a toilet room and water closet adjoin. The toilet rooms are fitted with tiled floors, marble wainscotting, and finest plumbing.

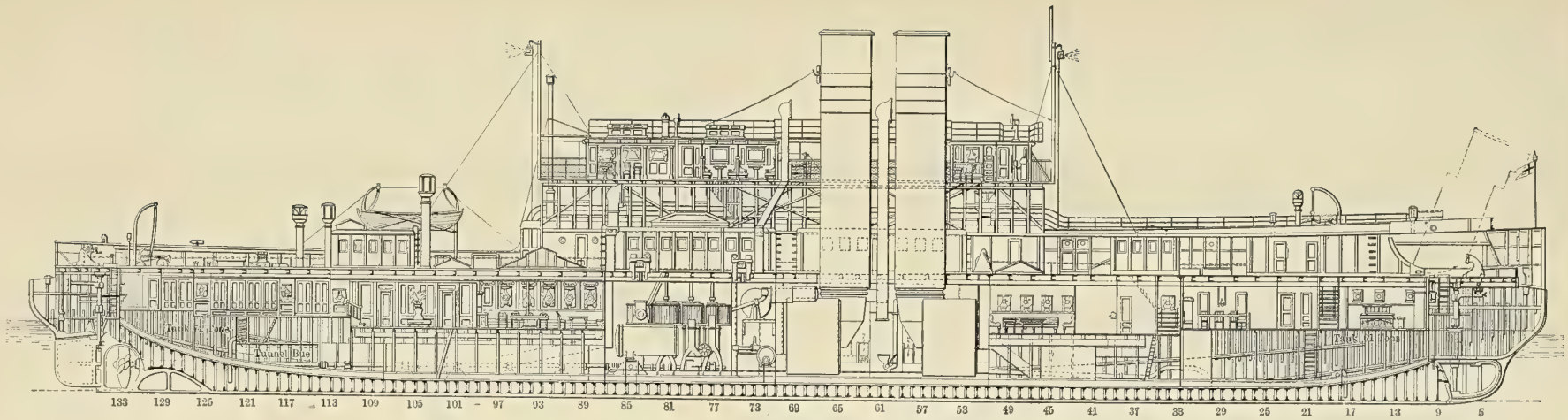
The whole of the space below maindeck and aft the engine-room is reserved to passengers of the first and second class. Two flights of stairs lead down from deck to a large lobby and well-lighted hall, handsomely finished in white japan with gilt trimmings. The floor here, as in other cabins of the vessel, is covered with linoleum and Brussels carpet. From the hall one passes forward into a very spacious dining saloon in fifteenth-century style, with furniture and walls of polished quartered oak. Doors from the hall lead to the pantry, the ladies' saloon, and the rooms of the captain and the stewardess, while a passage aft leads to the state-rooms,



THE TWIN SCREW CAR FERRY MECKLENBURG FOR THE DANISH GOVERNMENT RAILROAD.



DECK PLANS OF THE TWIN SCREW DANISH CAR FERRY PRINS CHRISTIAN. LENGTH OVER ALL, 258 FEET; SPEED, 14 KNOTS.

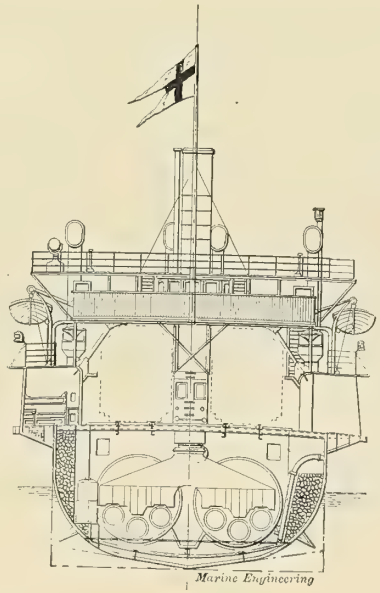


INBOARD PROFILE AND MIDSHIP SECTION OF DANISH STEEL CAR FERRY PRINS CHRISTIAN.

each of which is fitted for two persons and provided with sofas, folding washstands, luggage nets, etc. At the very stern are the gentlemen's lavatories.

At the forward end of the ship are the quarters for the crew, including staterooms for petty officers, toilets and mess-rooms. The third-class passengers' accommodations are between the crew space and boiler-room. Like the after cabins, they are well heated and ventilated by a complete system of steam coils and air ducts.

From the main deck, stairways lead to the tops of the deck houses, where are placed the life preservers. Over this deck are swung four lifeboats, suspended from automatic davits, which permit of rapid handling and require but one person to operate. A second stairway leads from these decks to the promenade amidships, as previously mentioned. This makes a splendid promenade 100 feet long by 40 feet in breadth and 25 feet above the water. Two teak deck houses are built here with large plate-glass windows. The forward one is the pilot house and chart room, which is just forward of the smokestacks, and the large after one contains the first cabin smoking room and the drawing room. The smoking room is finished in inlaid mahogany and fitted with leather-covered English sofas, while the saloon is beautifully paneled in white and gold with blue-plush furniture.



In order to carry the heavy loads of cars, the hull is built extra heavy, as is shown in the longitudinal elevation. The hull is divided into seven watertight compartments by six watertight bulkheads, which extend from the bottom to the main deck. The floors are continuous from side to side and are fitted with double reverse frames from end to end. The vertical center keelson is continuous and runs from forward collision bulkhead to after collision bulkhead, raising up at the bow and stern above the stern posts. It will be noted that at the bow a partially balanced rudder is fitted in the deadwood, as it is necessary to run backwards in going out of the harbor of Gjedser. Double frames of angle bar are spaced every two feet. The deck beams are placed on alternate frames and are of channel

section. A peak tank, containing 61 tons, is placed aft of collision bulkhead forward, and the after tank is 72 tons capacity. Wing coal bunkers are at the forward end of boiler-room, with chutes for filling from the main deck, and at after ends are two water ballast tanks, each containing 42 tons.

Steam is supplied by four single-end Scotch boilers fitted with natural draft. The uptakes lead to two elliptical funnels. A steam pipe from each boiler is carried to a steam drum, from which it is piped to the port and starboard engines. These engines are three-cylinder, triple-expansion, the high and intermediate pressures being fitted with piston valves, while the low-pressure cylinder has a double-ported slide valve. Steam exhausts to a common cylindrical condenser placed opposite the low-pressure cylinders on the center line of the vessel. Direct-acting air pumps are driven off the intermediate crossheads. Cylinders are supported by cast iron columns at the backs, *i. e.*, center of the ship, and forged steel columns at the face. A complete electric lighting system is installed.

Three other car ferries were placed upon this line shortly before the *Prins Christian* and resemble the latter in general arrangement. One, the *Mecklenburg*, is fitted with twin screws and two double-end Scotch boilers, and the other two, the *Friedrich Franz IV.* and the *Prinsesse Alexandrine*, are each fitted with feathering paddle wheels propelled by three-cylinder, triple-expansion inclined engines. There are two fire-rooms, one at either end of the engine space, and in each are placed two single-end Scotch boilers, each with its own smokestack. All three ships were built at the famous yard of F. Schicau, Elbing. The dimensions of these boats are as follows:

	Mecklenburg.	*Friedrich Franz IV.*	*Prinsesse Alexandrine.*
Length between perps..	262 ft. 0 ins.	265 ft. 6 ins.	264 ft. 0 ins.
Beam, molded	42 " 7 "	33 " 0 "	33 " 6 "
" over guards.....	54 " 0 "	57 " 2 "	57 " 2 "
Depth.....	21 " 4 "	18 " 10 "	18 " 7 "
Load draft.....	12 " 6 "	11 " 4 "	11 " 2 "
Height of rails above water at ends	10 " 2 "	10 " 2 "	10 " 2 "
Number of tracks on deck	Two.	One.	One.
I. H. P.....	2,500	2,500	2 500
R. P. M.....	.....	45	45
Speed, knots.....	13.5	13.5	13.5

Special Number of "Marine Review."—The *Marine Review* of March 12 is a special number devoted to the fitting out of ships and to a discussion of the shipping question in all of its various phases. The list of contributors embraces such prominent men as the Hon. George B. Cortelyou, Secretary Department of Commerce and Labor, U. S. Senator Wm. P. Frye, and Hon. T. E. Burton, Chairman of the Committee of Rivers and Harbors of the House of Representatives. Other specially prepared articles by authorities on marine subjects are given, and there are published plans of a new revenue cutter and the engines of the new battleships *Mississippi* and *Idaho*. The number is handsomely illustrated, making it in all an issue reflecting credit on its new publisher, the Penton Publishing Company, Cleveland, Ohio.

THE USE OF SUPERHEATED STEAM.*

BY PROF. STORM BULL.

Anybody who has followed the development of the steam engine during the last few years, cannot help having noticed the increased use of superheated steam, especially in European practice. All new steam plants of any considerable size, and even many smaller ones, on the continent of Europe are now using superheated steam; and in the last couple of years a number of plants utilizing superheated steam have been built in this country. It cannot be doubted, however, that the United States has been behind Europe in this respect and that it is high time that we try our very best to at least equal our competitors in this branch of mechanical engineering. Because of the comparative newness of the subject it is very possible that a great many American engineers do not realize its importance and it is, to a certain extent at least, the purpose of this paper to try to convince the skeptical ones that it is necessary to use superheated steam in order to attain the highest commercial efficiency of the steam plant—not of the steam engine alone—but of both engine and boiler combined. To avoid misunderstanding it is perhaps necessary to state at this place that this does not apply alone to the ordinary reciprocating steam engine, but also to at least the same degree to the steam turbine.

Probably most of you know that the use of superheated steam is not new, on the contrary, it is probably not far from 75 years old. The old masters in steam engineering, without doubt, realized the fact that the principal loss of efficiency in the steam engine was due to the condensation of steam in the cylinders, and, as is well known, they tried a great many means to reduce it and with varying degrees of success. There is no question in the minds of all competent authorities that the best means of reducing the condensation is in the use of highly superheated steam, and this has been known for a great many years. It almost seems that the "grand old man" James Watt anticipated or at least had a presentiment of nearly all the improvements in the steam engine which were to be introduced into its design during the last century. However, it seems that he had no knowledge of superheated steam or of its advantages, which seems very natural, as he really was the first one who had an adequate and thorough knowledge of saturated steam. The first mention of the practical use of superheated steam, which I have been able to discover, is found in the "Life of Richard Trevethick" of the Binner-Downs Mine in Cornwall, England. In this book it is stated that a certain Captain McGregor in 1828, in order to compete with a record established by an engine of a neighboring mine, whose cylinders had been insulated with sawdust, built a jacket of brick around the cylinder and the steam pipe, with an air space between the brick work and the iron and that he built a fire in this open space, by which means he increased the duty of his engine from 41,000,000 to 63,000,000 foot-pounds per bushel (86 pounds) of coal. Trevethick himself tested the 70-inch cylinder engine with steam at 48 pounds pressure and which made 8 strokes per minute, and he found that by using 5 bushels of coal in 24 hours under the cylinder, he reduced the

*Paper read November 4, 1903, before the Western Society of Engineers.

consumption of coal by the boiler from 108 to 67 bushels for the same work, showing a saving of more than 25 per cent. That such a saving must necessarily have aroused attention is evident; but it has been impossible for me to find any trace of it in the published records. In 1834 John Ericsson made some experiments with superheated steam, but no record of these experiments has been found. The next record that I have been able to find is that in 1845 Mr. Longridge made several experiments with superheated steam at low pressure, and in 1851, he was followed by Rafford in France who took out patents for a superheating plant.

From this time on, and lasting, perhaps, for 20 years, the interest in superheated steam was very active. Among the many engineers and scientists who contributed to the progress in this line, should be mentioned especially Hirn, Isherwood and Faraday. The first named made a great many experiments in 1857, using steam of 55 pressure and temperatures ranging from 410 to 490 degrees Fahrenheit. The results of his accurate experiments showed an increase in the economy of the whole plant of from 20 to 27 per cent.

During the fifties and sixties, however, the principal use of superheated steam was found in the marine engine, and in the literature of the subject quite a number of tests of steamships with and without the use of superheated steam may be found. Penn showed an increase of economy of 20 per cent. for the steamer *Valletta,* with a steam pressure of 20 pounds. The Parson and Pilgrim's superheater was especially designed for marine practice. It consisted of a number of semicircular pipes placed in the furnace, by which means it is stated that a saving of one-third in fuel was realized. The English Board of Trade, however, objected to the use of superheated steam on the ground that the high temperatures used were liable to break the steam up into its elements, thereby making it unnecessarily dangerous. Fortunately, Professor Faraday, who fully investigated the matter, was able to convince the authorities that this objection was unfounded. The tests of marine engines made at about the same time, during the latter part of the fifties, show gains in economy of from 20 to 30 per cent., always depending upon the amount of superheat which was available.

Our own Isherwood was at first very skeptical as to the practical use of superheated steam. He at first declared against it on the ground of injury to the cylinder, difficulty of lubrication, extra weight and short life on board of ship. Later on, however, he recommends the use of superheated steam because of the gain in economy of 30 per cent. shown by his experiments, but suggests that the limit of superheat be placed at 100 degrees Fahrenheit, on account of the difficulties of lubrication. In 1863-1864, he made extensive tests on the steamer *Eutaw,* which had a single cylinder inclined engine with poppet valves and a Stevens' adjustable cut-off. The best results of these tests show a gain in steam economy of 18 per cent. and 15 per cent. in coal consumption.

During the years from 1850 to 1870 a great many superheaters were installed, especially on shipboard, notwithstanding the fact that engineers always found great difficulties with respect to the lubrication and that the material of the superheaters did not withstand the action of the heat for a very long time. That there was trouble with the lubrication should not surprise anyone when it is remembered that none of our present day mineral oils were known at the time, and that the only available lubricating materials were animal oils and fats. The steam pressure used up to that time did not exceed 50 pounds, at least not on ship-board, and for such a pressure the animal oils or tallow answered very well, even if the steam was superheated perhaps 100 degrees Fahrenheit. But the latter part of the sixties saw the introduction of the compound engine with its accompanying higher pressure, and this proved to be a very effective damper to the use of superheated steam—and for two reasons. The first one was the very much greater economy of the compound engine as compared with the single expansion engine using steam of lower pressure, and because of this increased economy a saving of both space and weight, a very important factor in a ship. The second reason was that the difficulties in the way of proper lubrication of the cylinders became so great that it was found necessary to reduce the superheat to such an extent that the gain from it in economy became almost imaginary and which certainly did not warrant the expense of the installation of the superheater. The universal use of the compound engine on shipboard, therefore, very soon made the use of superheated steam impossible on steamships. It had been much less used in stationary practice, but with the gradually increasing pressure it also disappeared here. It is true enough that the use of mineral oils very soon after this time became general, but our present day heavy lubricating cylinder oils were not known then, and, in addition, and this is much more important, the attention of all the foremost engineers of the world, working in this line, were now exclusively directed towards the improvement of the economy of the steam engine by means of the use of higher pressure and of the compound principle; they lost sight of the superheated steam, presumably, because of the many bad reports regarding its use.

You all are aware of the fact that the improvement of the economy of the steam engine during the last thirty years of the last century was all due to the increasingly higher steam pressure and to the introduction of the compound and multiple expansion engines, if exception be made concerning the greatly improved mechanical details, especially with respect to valve gear and governor. But towards the end of the last century nearly all competent engineers agreed that the improvement due to the causes just mentioned had about reached its limit. The increased cost of making more than a triple or quadruple engine was not warranted by the very slight increase in economy due to an additional cylinder—at least with the high steam pressure then practicable. Because of the available material it had been impracticable—perhaps unprofitable—to design boilers for a higher pressure than, say, 250 pounds. It is due to this fact that the attention of the engineering world has within the last half dozen years increasingly been directed to the use of superheated steam as a means of improving the still lamentably low economy of the steam engine, and it is my opinion that the history of these years has conclusively shown that for the present, at least, the outlook in this direction is very

much brighter than in any other. I realize very fully that Professor Lewicky, of the Polytechnic School of Dresden, Saxony, is perfectly correct when he states that all that is necessary in order to get a theoretical efficiency of the steam engine of 80 per cent. is for the practical engineers of the world to supply material from which cylinders and boilers could be made which could properly resist pressures corresponding to a temperature of something like 1800 degrees Fahrenheit and also such temperatures. Unfortunately, there is at present no prospect that such a material will be supplied, at least in the near future, and, in fact, as stated above, the limit as to pressure has just about been reached for the present, and it is but natural that engineers should be looking out for other means of improving the economy of the steam engine which is still our greatest source of motive power.

During all the years when it seemed that all interest in superheated steam had died out, there were still a few firm adherents working in this line. Among them must be specially mentioned Hirn, in Mulhouse, Alsace, his successor Schwoerer, and William Schmidt, in Germany. More than to any other it is due to these persons that at the present time superheaters have become a practical success. Schwoerer originated the ribbed cast iron superheater used extensively at the present time, whereas Schmidt used wrought iron coils and he was the first to use in practice highly superheated steam, the superheat often being more than 200 degrees Fahrenhit. Some of you will no doubt remember the sensation that was created when some eight years ago the results of a series of tests of a boiler and engine built especially for superheated steam by William Schmidt were reported in the technical papers. The tests had been conducted by Professor Schroeter of Munich, probably the highest authority in this branch in Germany, so that the results could not be doubted. Although the engine was quite a small one, yet it was shown that the consumption of steam had been only about 10.4 pounds per indicated horse power per hour, when using superheated steam; whereas the consumption of steam per brake horse power hour was only about 12.3 pounds, the engine developing 75 horse power. The statement of the consumption by an engine of a certain number of pounds of superheated steam per horse power per hour does not give the means for a true comparison of the performance of this engine with one using saturated steam. It is much more equitable to base the comparison on the consumption of coal or the number of heat units converted into work. In the test spoken of it was shown that the amount of coal used per indicated horse power per hour was only about 1.3 pounds, certainly an extraordinary result for an engine of only 75 horse power. The engine in question was a tandem compound, both cylinders being single acting; throughout of very original design and built especially for the use of highly superheated steam. The boiler which was also built and designed by Mr. Schmidt, was also very original and has since proved to be excellent in every way. As a result of this first test, Mr. Schmidt's engines became very popular and at the present time several hundred are running in Germany and adjacent countries.

As is well known there are two essentially different arrangements of the superheater with respect to the boiler. The most common is to install a coil in the boiler setting proper, through which the saturated steam taken from the top of the boiler is drawn on its way to the steam engine. If a high degree of superheat is wanted, the coils must be installed in such a way that the hot gases will strike them long before they have been cooled sufficiently to allow them to escape into the chimney. This arrangement has, as is well known, been extensively employed by the Babcock & Wilcox Company. On the other hand, if only a slight superheat is desired the coils may be placed so that the gases on their way from the boiler to the chimney will surround the coils. It may, however, be stated at this place that this last arrangement is usually not satisfactory, as the degree of superheat is so small that the gain in economy of the steam engine frequently does not warrant the installation of the superheater.

The second arrangement is to install an independent superheater with separate furnace, and a great many installations of this kind are found at present, especially on the continent of Europe. Many competent engineers have expressed their doubts as to the possibility of a gain in economy due to such installations, but repeated test of a number of such plants have conclusively shown that these doubts were not warranted by the facts. When properly designed and run, such installations have invariably shown an economy as compared with the ordinary boiler and engine arranged for saturated steam.

Both wrought iron or steel, and cast iron are at the present time being used for superheaters. Because of the high temperature to which the material of the superheater will be raised, it is impracticable to have ordinary flange joints or couplings exposed to the hot gases. If therefore the superheater consists of a series of steel pipes of small diameter, they must be bent into coils, something like the ammonia pipes in a refrigerating machine. If, on the other hand, the superheater is built of cast iron it is usually built along the lines in which Schwoerer originally made them; a number of large, straight cast iron pipes connected by flanged return bends, the flanges being placed in such a manner that they cannot be reached by the hot gases, these pipes being also provided with a large number of external ribs so as to increase the heating surface. It is probable that the latter type will suffer less than the former type because of the action of the heat, both because its material is cast iron and because the walls of the pipes are quite heavy; but on the other hand, the heating surface in the former type will be much more effective—both because of the fact that the walls of the pipes are so thin and because the steam to be superheated is here distributed in a large number of small pipes, so that all steam is much closer to the hot gases from which the superheat is to be derived. The difficulties which were encountered years ago with respect to the wearing out of the superheaters have now been overcome, as can be readily seen from the fact that there are now in service superheaters which have been used continuously for eight years and without any important repairs. The number of plants now running in continental Europe is several thousand, of which several hundred are more than four years old, and any one familiar with the periodical technical literature, of Germany in particular, will

agree with me that the published records of these plants so far as they can be found all testify to the fact above stated that the criticism, so often heard in former years that superheaters deteriorated very rapidly, is not true at the present time.

It was also to be expected that the use of such high temperatures in the engine cylinder would create new difficulties, not alone with reference to the proper lubrication of the same, but also and perhaps still more so, with regard to the great expansion of the parts of the cylinder itself. But it can also be stated positively that all these difficulties have been overcome. Just as in the gas engine where the temperatures are very much higher, and where these difficulties have been overcome by the proper design of the cylinder, so in the steam engine our modrn engineers have found the proper way to proportion the various parts of the cylinder in such a manner that the expansion due to the high temperature does neither produce breaks in the casting nor leaks at the stuffing boxes. With reference to the lubrication it is only necessary to remind you of the existence of our modern heavy lubricating oils which made our modern gas engines possible. However these difficulties also explain the fact that William Schmidt previously mentioned, and who is more than anybody else entitled to the credit of the progress in the use of superheated steam during these late years, designed his first engines for superheated steam as single acting, probably in imitation of the only successful gas engine then existing, in which both the proper lubrication of the cylinder and the taking care of the expansion of the same had been satisfactorily accomplished. But at the present time, eight years since Schmidt first achieved success, we have both double acting gas engines and steam engines, using highly superheated steam, and when properly designed and looked after, they run satisfactorily. What is more, in my mind at least, both the double acting gas engine and especially the double acting engine for superheated steam, will be the type of the future, if recent progress in these lines is to be any criterion for what is going to follow.

The latest steam engine designed for superheated steam does not look very different to the uninformed from an engine using saturated steam of very high pressure, although a good many details may be different. In this connection it might be mentioned that the conclusive evidence of the experience of recent years is that Corliss valves are not adapted for the use of highly superheated steam and that consequently, we in our country, will have to modify the design of our most economical engines in a very essential part before we can use with profit, steam superheated to a degree which will show an improvement in economy to such a degree that it will warrant its use. As was intimated before, it is not alone the reciprocating steam engine proper which benefits from the introduction of superheated steam. The steam turbine, so far as the experience goes at present, is destined, it seems, to improve its economy to a higher degree even than the reciprocating engine. Experiments seem to show it, and the reasons for it advanced by the various investigators seem perfectly plausible. In what follows I propose to present to you some of the principal tests of engines using superheated steam and conducted by competent authorities, as well as the results of my limited experience in this direction.

The principal results of the test of Professor Schroeter of the Schmidt engine and boiler in 1895 and mentioned before, were as follows:

Size of engine—12 1-4 in. x 27 3-16 in. x 19 1-2 in.; vertical, tandem, compound, making—

	1st test.	2d test.
Pressure	156.2	159.0
Brake horse power	61.72	62.18
Superheat, degrees Fahrenheit	235.0	281.0
Steam in lbs., per I. H. P., per hour	10.91	10.19
Steam in lbs., per brake H. P., per hour	12.61	12.34
Coal in lbs., per I. H. P., per hour	1.36	1.26
Coal in lbs., per brake H. P., per hour	1.57	1.52
Per cent. of heat acounted for in saturated steam	65.0	63.7
Per cent. of heat in the superheat	6.9	8.2
Per cent. of heat given to feed water	6.9	6.6
	78.38	78.5

Schroeter also reports on a similar engine, a little larger however, of 90 horse power, using superheated steam, which engine used only 9.95 pounds of steam per horse power per hour and 1.43 pounds of coal, certainly a very remarkable result for such a small engine.

In 1896 Professor Ripper, of England, published the result of a series of tests of a small Schmidt engine using superheated steam. The size of the engine was 7 1-16 by 11 3-4 inches, it made 180 revolutions per minute. He used both saturated steam and steam of different degrees of superheat in order to show the influence of the same.

	1.	2.	3.	4.	5.	6.
Steam pressure, lbs., absolute	87.5	79.9	86.1	87.6	118.4	116.0
Temperature of steam, deg. F.	329.0	412.0	590.0	667.0	612.0	653.0
Degrees of superheat, F.	0.0	88.0	261.0	338.0	263.0	306.0
Indicated horse power	16.55	16.32	16.43	16.59	17.73	17.60
Lbs. of steam per hour per I. H. P.	39.33	34.66	21.48	19.13	18.84	17.58

It will be apparent from this table how rapidly the consumption of steam decreases with the increase of the superheat. With 338 degrees of superheat the number of pounds of steam used is not quite one-half of that used for saturated steam. In itself this performance of a single expansion, non-condensing engine, indicating only some 18 horse power and using less than 20 pounds of steam per horse power per hour is very startling.

In 1895 a large, triple expansion engine for superheated steam was installed in Augsburg, Bavaria. The old boilers were to be used and these could not carry more than 85 pounds pressure; but in connection with these Schwoerer superheaters were installed. Professor Schroeter conducted some very exhaustive tests on this plant, using both superheated and saturated steam in order to find out whether the moderately superheated steam showed any gain.

The dimensions of the engine and the main results of the tests are as follows:

Cylinder diameters, 27 1-2, 43 3-8, 45 3-8, 45 3-8.

Stroke, 63 in. Revolutions per minute, 60.

	1.	2.	3.	4.	5.	6.
I. H. P.	1180.5	1167.3	1127.8	1200.8	976.9	993.1
Steam pressure (gauge)	84.34	83.35	84.21	84.77	83.35	83.92
Temperature, deg. F.	414.7	418.1	420.1	327.1	326.1	326.5
Degree of superheat	87.9	92.0	92.3	.....	.....	.....
Steam per H. P. per hour	13.06	12.68	12.05	14.31	13.55	13.22

Although the degree of superheat here is very moderate and the steam pressure very low, yet a decided gain in economy is shown.

A small Schmidt steam engine and boiler installed at Ascherleben, Germany, was also tested by Professor Schroeter. The cylinder had a diameter of 9 7-8 inches and a stroke of 15 3-4 inches and was single acting; it made 150 revolutions per minute. A series of tests were made to show the influence of the cut-off and of various degrees of superheat. The most important results were as follows:

	1st test.	2d test.
Indicated horse power	297.1	326.1
Steam pressure, in pounds (gauge)	99.4	101.8
Temperature of steam, degrees Fahrenheit	337.1	495.0
Superheat, degrees Fahrenheit	0.0	156.0
Pounds of steam per I. H. P., per hour	14.1	11.9
Heat units per I. H. P., per hour	286.0	257.0
Percentage of heat units contained in steam given to walls of high pressure cylinder during admission period	11.84	3.37
Percentage of heat units contained in steam given to walls of low pressure cylinder during admission period	27.3	21.6

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Cut-off, per cent	16.1	22.9	35.0	41.1	48.0	22.5	15.7	23.4	36.5	26.1	24.3
2. Steam pressure, by gauge	120.0	115.7	111.4	98.7	95.8	113.6	115.6	115.0	105.1	90.9	98.7
3. Temperature, degrees Fahrenheit	669.0	671.0	673.0	680.0	689.0	667.0	574.0	588.0	597.0	491.0	408.0
4. Superheat, degrees Fahrenheit	319.0	324.0	328.0	343.0	354.0	321.0	227.0	241.0	206.0	160.0	71.0
5. Consumption of steam per horse power per hour	17.85	17.59	18.03	17.54	18.03	17.45	18.86	18.52	18.93	23.08	27.68

The results conclusively show that the cut-off has very much less influence on the economy of the steam engine when running with superheated steam than with saturated, because there is very little change in economy between a cut-off of 16 per cent. and one of 48 per cent., whereas it is probable that if the engine had been running with saturated steam this difference would probably have been at least 25 per cent. It is also well known that the interchange of heat between the steam and the cylinder walls is very rapidly reduced with increased superheat, so that, for instance, the heat absorbed by the walls during the admission period is almost zero when the steam is superheated from three to four hundred degrees. From some tests to be quoted later this will be very plain. But in passing it is perhaps worth while to call attention to the fact that the gain in economy due to the use of superheated steam is not alone due to the greatly reduced condensation in the cylinder, a fact which everybody recognizes, but also and perhaps in just as high a degree, to the greatly reduced interchange of heat between the walls of the cylinder and the steam while it is in the superheated state, this being due to the absence of water, which is always adhering to the walls when saturated steam is being used.

From a number of carefully conducted tests it has been shown that the steam at the end of the expansion in the high pressure cylinder of a compound engine is still slightly superheated, if the superheat to begin with is from 200 to 300 degrees Fahrenheit. This is especially true if the cylinder is jacketed with superheated steam, and under such circumstances it would almost seem that it should be possible to eliminate all condensation from the high pressure cylinder, and at least reduce the heat interchange to such an extent that it hardly needs to be considered. In a single expansion cylinder or engine this would not be true, at least with the degree of superheat which is being used at present, as necessarily the change in temperature of the steam here would be very much greater. To prove these statements I submit the results of two sets of tests made by Professor R. Doerfel; one for a compound and one for a triple expansion engine.

Compound engine at Haunsdorf, Germany.

Triple expansion engine at Zwoden, Bohemia.

	1st test.	2d test.	3d test.	4th test.
Indicated horse power	801.8	793.9	654.0	612.5
Steam gauge pressure, in pounds	Average, 138.5			
Temperature of steam, deg. Fahrenheit	495.5	496.0	512.8	499.5
Superheat, deg. Fahrenheit	135.9	137.0	153.2	140.1
Pounds of steam per I. H. P., per hour	11.07	10.95	10.75	10.95
B. T. U. per I. H. P. per hour (degree)	237.8	235.5	232.8	236.1
Percentage of heat contained in steam given to wall of high pressure cylinder during admission period	2.07	1.75	3.3	4.73

In the case of the compound engine, the direct comparison between superheated and saturated steam is made, and as will be seen the amount of heat given to the walls of the cylinder during the admission period is reduced to about one-fourth of what it is for saturated steam. For the triple expansion engine, it will be seen that the loss of heat is so small that it hardly needs to be taken into account in practical engineering. It should also be remembered that in both cases the degree of superheat is comparatively low, and that still better results can be expected and are in fact realized with a higher degree of superheat.

That the consumption of steam in both cases is very low should also be noticed, in fact a great deal lower than can be realized when saturated steam is used, but obviously if the degree of superheat had been greater, still better results would have been obtained.

In studying the files of the technical periodical literature of continental Euorpe for the last few years, one finds the records of a very large number of tests of plants using superheated steam, and all the records so far as I have seen them point in the same direction.

New Ferryboats for the Jersey Central Railroad.—The Central Railroad of New Jersey has awarded the contract for two steel double decked ferryboats to the Harlan & Hollingsworth Company, Wilmington, Del., These boats, designed by Wintringham & Wells, naval architects, 32 Broadway, New York, N. Y., are practically duplicates of the four new boats recently built for the Jersey Central and are to be run in the new Twenty-third street service.

Old Steamer Massachusetts Broken Up.

It is indeed a sad sight to see a vessel which for years has done good service and become what might be called a "landmark" in certain waters, laid up as unfit for service and to be eventually broken up.

One of the most familiar vessels on the waters of New York harbor has been the side-wheel steamer *Massachusetts,* which since the year 1877 has, with but few and brief interruptions, passed daily in or out of this harbor. The above view, which is reproduced by courtesy of the *Boston Globe,* show the final resting place of this old steamer as she lay broadside on the

THE OLD LONG ISLAND SOUND STEAMER MASSACHUSETTS BEACHED AT APPLE ISLAND, R. I., FOR BREAKING UP.

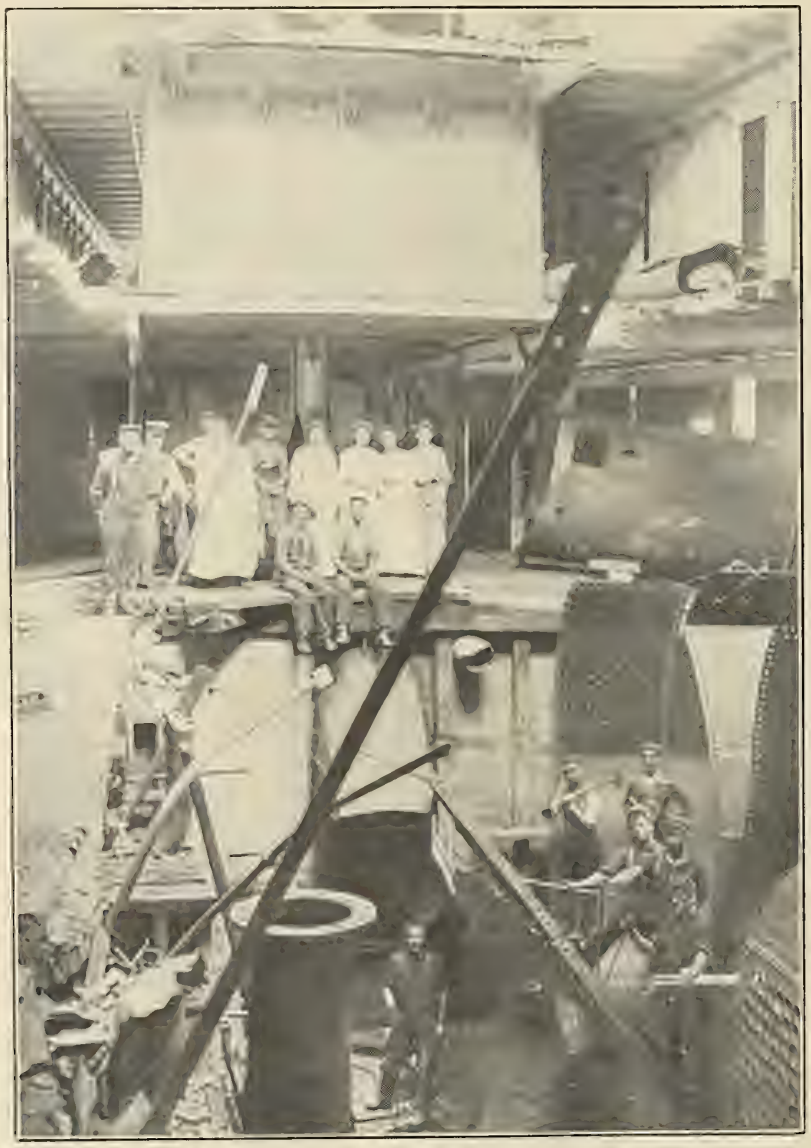
MARINE ENGINEERING DATA CARD. **APRIL, 1904.**

NAME—Massachusetts. NATIONALITY—American. TYPE—Paddle wheel sound steamer.

LAUNCHED—1877. BUILDER—H. Steers. OWNER—N. Y., N. H. and H. R. R.

Construction, material	wood
Length over all	340 ft. 0 ins.
" between perps	324 " 0 "
Beam over guards	76 " 0 "
" molded	46 " 0 "
Depth of hold	16 " 4 "
Mean draft, light	10 " 0 "
" " loaded	11 " 4 "
Displacement	3,000 short tons
Tonnage, gross	2,607
" net	2,171.1
Cargo capacity in cars	55
Coal bunker capacity	120 tons
Maximum speed	16 1-2 miles
Engines, type of	Beam
Cylinder diameter	90 ins.
Stroke	14 ft.
Rev. designed	18
I. H. P.	2,800
Cooling surface in condenser	5,753
Wheels, type	paddle, radial step bucket
" diameter of paddle	38 ft. 11 ins.
" width of paddle	6 ft.
" depth " "	28 ins.
Boilers, number of main	2 steel, 4 iron
Type	Scotch
Diameter	12 ft. 8 ins.
Length	two 12 ft. 6 ins.; two 13 ft. 2 ins.; two 11 ft. 6 ins.
Working pressure on main	35 lbs.
Furnaces, 18 plain, diameter	40 ins.
G. S.	466 sq. ft.
H. S. main boilers	7,923 " "
Coal consumption per hour (approx.)	4.7 tons

beach at Apple island. For many days a gang of workmen were employed in dismantling and breaking up the machinery for scrap. Some of the auxiliaries were in sufficiently good condition to be used again, and all of the iron and interior fittings of any value were removed. Then it was that a fire was started in several parts of the old hull and an immense bonfire made of this old ship—a much more fitting end than that which comes to most craft, which after being dismantled are fitted up for barges.



THE WRECKERS AT WORK ON THE MASSACHUSETTS TAKING OUT THE METAL PREVIOUS TO BURNING HER.

The *Massachusetts* was a favorite boat in her day. She was built of wood at the yard of Henry Steers, Greenport, L. I., and the joinery was designed and installed by William Rowland, while the machinery was made by John Roach and Son. She was launched in 1876, and in May of the following year established with her running mate, the *Rhode Island*—which was afterward lost—the Providence line to Boston, between New York and Providence, connection at the latter port being made by rail to Boston. These boats were owned and operated by the Providence and Stonington Steamship Company.

On the night of October 4 the same year, during a heavy gale, she went ashore at Rocky Point and there continued for several hours, and when the let-up came there were four holes in the bottom and it was feared that she would be a total loss. The Coast Wrecking Company undertook to salve the ship, two weeks afterward succeeded in floating her and towed her to New York, where she was dry-docked and repaired, the damages amounting to over $70,000.

From that date on the *Massachusetts* proved to be a fortunate ship, for she had, comparatively speaking, but few accidents during the 28 years of service. When she came out she was fitted with arc electric lights in her main saloon, which is stated to be the first install-

ment on board ship of an electric-lighting plant. In 1885 the lights were replaced by the Brush incandescent system. The dimensions of this old boat are presented in the table on page 175.

She was fitted for carrying 628 passengers and had 184 state rooms in all. The feature of this boat was that the dining room was on the main deck aft. On former sound boats this room was placed on the lower deck, but since her day the new boats have adopted this arrangement. The engines were of the usual walking-beam type, designed for a working pressure of 35 pounds and to run at 18 revolutions, and indicated 2,800 horse power. This power drove the vessel at a speed of a little over 16 miles average. The side wheels were of the radial-step bucket type, 38 feet 11 inches in diameter.

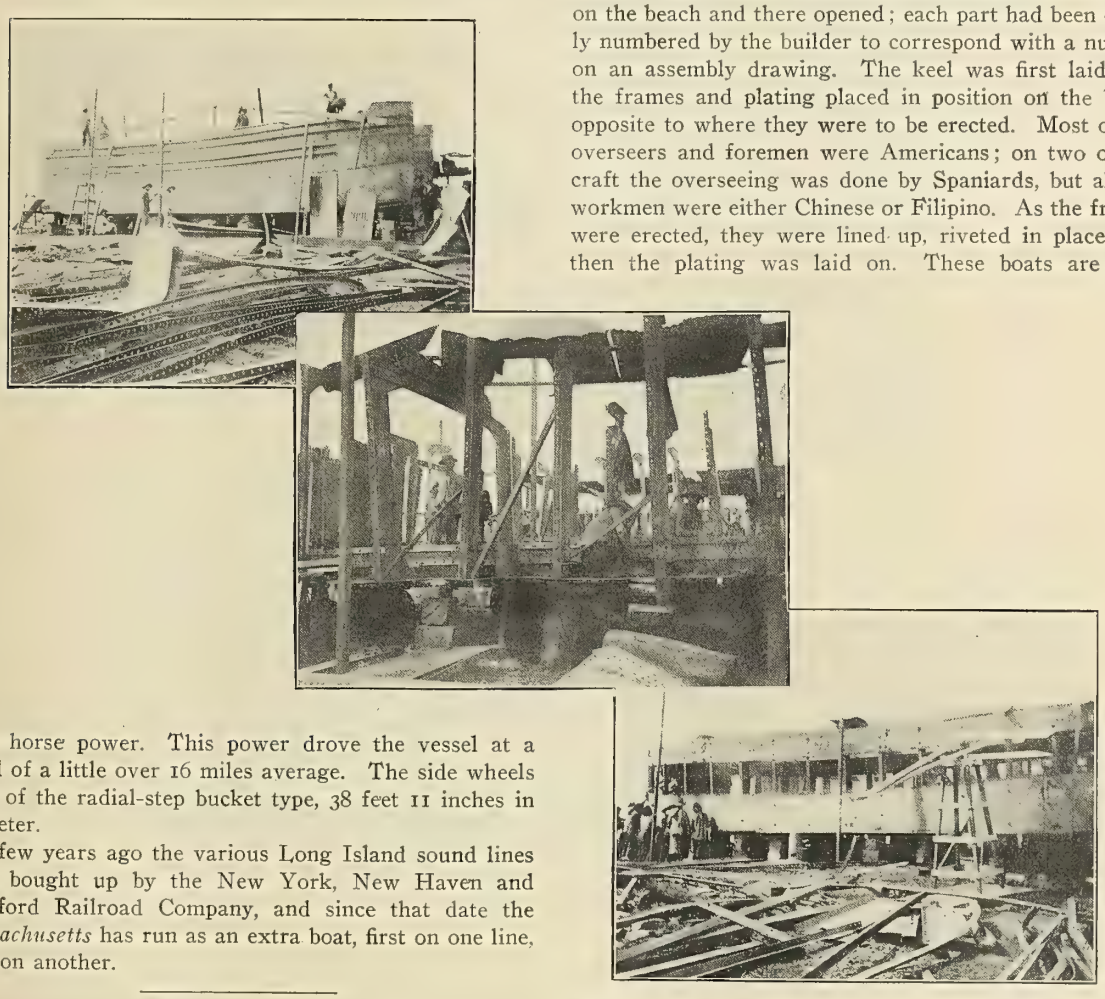
A few years ago the various Long Island sound lines were bought up by the New York, New Haven and Hartford Railroad Company, and since that date the *Massachusetts* has run as an extra boat, first on one line, then on another.

Revenue Cutter in Baltimore Fire.—The United States Revenue Cutter *Windham* did gallant service along the water front of Baltimore during the tremendous fire of February 8 and 9. The *Windham* took up a position near a large lumber yard, which was threatened by the approaching flames. The steamer, which was at all times in dense smoke and flying cinders, brought into play all of her fire apparatus, and kept the flames from spreading to the lumber. After the fire was extinguished, the officers and crew of the *Windham* were assigned to patrol duty on the harbor. The *Windham* was in charge of Capt. S. E. McGuire, and the other officers were Lieutenants Ridgely and Wheeler, Assistant Engineer Bryan and Cadet Crapster.

New Boats in the Philippines.

Several new steel craft have recently been placed in commission in the Philippine islands for use in the quartermaster's department of the United States army. These boats were built in the United States, then taken apart and shipped in crates to Manila, where they were erected.

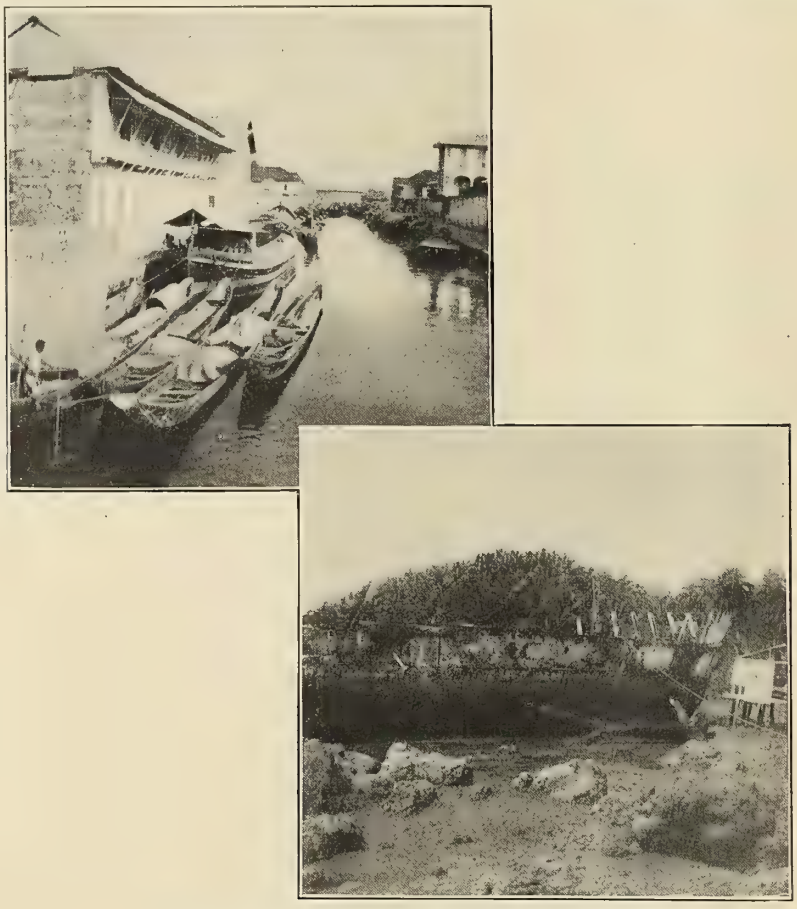
I passed the yard daily and was much interested in watching them grow. In fact, I met several Spanish marine agents and others watching with much interest the progress of building, as they were considering placing orders with the American concern for similar boats. The crates containing the material were placed on the beach and there opened; each part had been clearly numbered by the builder to correspond with a number on an assembly drawing. The keel was first laid, and the frames and plating placed in position on the beach opposite to where they were to be erected. Most of the overseers and foremen were Americans; on two of the craft the overseeing was done by Spaniards, but all the workmen were either Chinese or Filipino. As the frames were erected, they were lined up, riveted in place, and then the plating was laid on. These boats are constructed with several water-tight compartments, so that if the shell in any one were punctured, there is sufficient buoyancy in the remaining holds to float the boat.



VIEWS TAKEN DURING THE ERECTION OF AMERICAN BUILD STEEL BARGES AT MANILA.

Right alongside these steel boats the natives were erecting small steam and sailing craft of wood, and a comparison of the two methods and speed of construction was very interesting. The iron boats are put up rapidly, as compared with the progress on a native boat of the same size. Some of the old fashion wood craft require several months in building. The keel is usually a great log properly hollowed out, and this takes many months of chipping, gouging, and scraping, and then

the frames are adjusted and the side planks put on. Very few iron boats are used; in fact, in some craft no metal work is used at all, strong hardwood pins taking the place of the bolts. These pins are driven securely through the timber work, and made water-tight by native gum. The planking is calked, as usual. The native boats are very poor sea boats, as I know from several unfortunate experiences in traveling in them. While I was crossing Lake Lanoa, a slight wind blowing, the boat itself sank two feet below the surface, but was held there by the outriggers. We stood upright in the boat while the natives continued paddling across as best they could with the boat under the water and the bamboo outriggers supporting the whole affair.



NATIVE CRAFT AT MANILA. AN ABANDONED NATIVE BARGE.

The metal boats will no doubt prove an innovation to this part of the world and will give good service in lightering cargoes from the ships in the harbor to the cities and towns along the shoal water-fronts. I believe that other islands would be quick in adopting this form of boat.

Ex-Soldier.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 40 vessels of 15,208 gross tons built in the United States and officially numbered during the month of February, 1904. The largest steel steam vessel included in these figures was the *Edwin F. Holmes,* built at Loraine, O., by the American Shipbuilding Company, and of 4,787 gross tons.

Shipbuilding Bounties as Applied in Japan and Abroad.

A paper of this title was presented by Mr. K. Uchida, director of the Marine Bureau, Department of Communications of Japan, at the Osaka meeting last summer of the Japanese Society of Naval Architects, which strikingly illustrates what can be done in building up a merchant marine under government subsidy.

The first part of the paper mentions the subsidy of other countries, and then gives the history of the early development of the Japanese mercantile marine. In 1867 the number of ships on the Japanese register was 46 of 17,000 gross tons, while at the outbreak of the China-Japan war in 1894, the number had grown to 140 vessels with a total tonnage of 210,000, and during that year 67 vessels of 100 tons and upwards and aggregating 102,300 gross tons, were added to the register. Of these 67 only 29 of 6,300 tons were built at home. At this time Japan owned but one ship of over 1,000 tons, and that a wooden one.

In 1896 the government of Japan resolved to encourage both the shipping and the shipbuilding of the country and legislation was enacted to remain in force for eighteen years. This act provides for Japanese-built ships as follows: Those between 700 and 1,000 tons to receive a bounty of 12 yen* per ton; those above 1000 tons, 20 yen per ton. An additional sum is paid upon

* A yen is about equal to one dollar.

the machinery of vessels of 700 tons and over at the rate of 5 yen per indicated horse power developed on trial, regardless of the size of the engine. There have been built, or are now under construction, 41 ships, which have taken or will take advantage of the act, the total tonnage aggregating nearly 100,000 gross tons.

In addition to this subsidy to ship builders, Japan has paid a handsome subsidy to the steamship lines, and, while of late years this amount has been reduced, the Government has entered into a special contract with first-class steamship companies which operate the regular lines. The contracts now in force are with the Nippon Yusen Kaisha, the Toyo Kisen Kaisha, the Osaka Shosen Kaisha, the Daito Kisen Kaisha, H. Oie & Company, and the Hunan Steamship Company. The first-named company operates the following lines:

1. Yokohama to Melbourne, employing three steamers of 3,500 tons and above; speed, 16 knots and above. A monthly service. Subsidy, $270,000. Contract runs from April, 1901, to March, 1906.

2. Yokohama to Bombay, employing three steamers of 3,000 tons and above, 10 knots and above. A monthly service. Subsidy, $90,000. Contract runs from April, 1901, to March, 1906. 3. European Line, employing twelve steamers of 6,000 tons and above; 14 knots and above. A fortnightly service. Subsidy, $1,360,000. Contract runs from January, 1900, to December, 1909. 4. Hong Kong to Seattle, employing three steamers of 6,000 tons and above; 15 knots and above. A four weeks' service. Subsidy, $330,000. Contract runs from November, 1901, to December, 1909.

Besides these, this company carries the mails from Yokohama to Shanghai, from Kobe to Korea and North China, Kobe to Vladivostock, Kobe to Otaru, and Aomori to Mororan.

The Toyo Kisen Kaisha has the following route and subsidy:

Hong Kong to San Francisco, employing three vessels of 6,000 tons and above, and 17 knots and above. A four weeks' service. Subsidy, $517,000. Contract runs from January, 1900, to December, 1909.

The Osaka Shosen Kaisha has the following:

1. Shanghai to Hankow, employing three steamers of 2,000 tons and above; 11 knots and above. A bi-weekly service; in winter, three times a fortnight. Subsidy, $125,000. Contract runs from January, 1898, to December, 1907. 2. Hankow to Ichang, employing two vessels of 1,500 tons and above; 10 knots and above. Service, six times a month; in winter four times. Subsidy, $56,000. Contract runs from January, 1899, to December, 1907. 3. Kobe to Korea, employing two steamers of 700 tons and above; 10 knots and above. A three weeks' service. Subsidy, $15,500. Contract runs from October, 1900, to September, 1905.

The first two of the other companies mentioned run services on Chinese rivers and on the Japanese sea, respectively, and receive subsidies, the one of $29,550, the other of $70,000.

The total annual payments on account of the special services above detailed amount to $3,000,000.

Progress in England of the Marine Steam Turbine.

The development of the steam turbine for marine purposes continues to occupy very considerable attention and no doubt is now entertained as to the future. Twelve ships are now being constructed for turbine engine propulsion and several firms have now secured the license from Messrs. Parsons for the manufacture so that with competition there is likely to be a material reduction in the cost. In addition to the two Clyde steamers, a third for Calais and Dover service, a fourth for the Newhaven and Dieppe run, there has just been floated a fifth merchant steamer for the service between the nearest land points separating Britain and Ireland, *i. e.,* between Stranraer and Larne. There will be launched within the next two or three months two boats for the Midland Railway Company, also for the Irish service, and one for service between Australia and New Zealand. In these instances the difference in price is inconsiderable and it would seem as if in the future the turbine would have the advantage. In addition to the two Allan liners for the Atlantic service, a third Atlantic liner has now been ordered for the Cunard Company. This is a vessel of 16 or 17 knots speed, a duplicate of ship with reciprocating engines now building for the Cunards, and must not be confused with the proposed high speed leviathans.

The question of fitting the turbine to these two high speed subsidised mail liners for the Cunard Line has not yet been settled, but in view of the progress made by the committee appointed by the company to report on the subject, there is every prospect that the vessels will be laid down by May or June at the latest, and all the indications point to the adoption of the Parsons turbine system, working four shafts. The four shafts is considered best for the distribution of power and for propulsive efficiency. At present experiments are being made in the Admiralty experimental tank with a view of determining which system of bracket is preferable, as it was found when the first tests were made that a very serious diminution of efficiency resulted from such large obstructions to the stream lines at the after end of the ship. This matter, as well as the proximity of propellers to the hull of the ship, is a problem which will require to be faced in connection with the use of multiple screws. The research work of the committee has shown that a considerable decrease in the weight of machinery cannot be realized even by the adoption of the turbine, and consequently the ships are likely to be of great size.

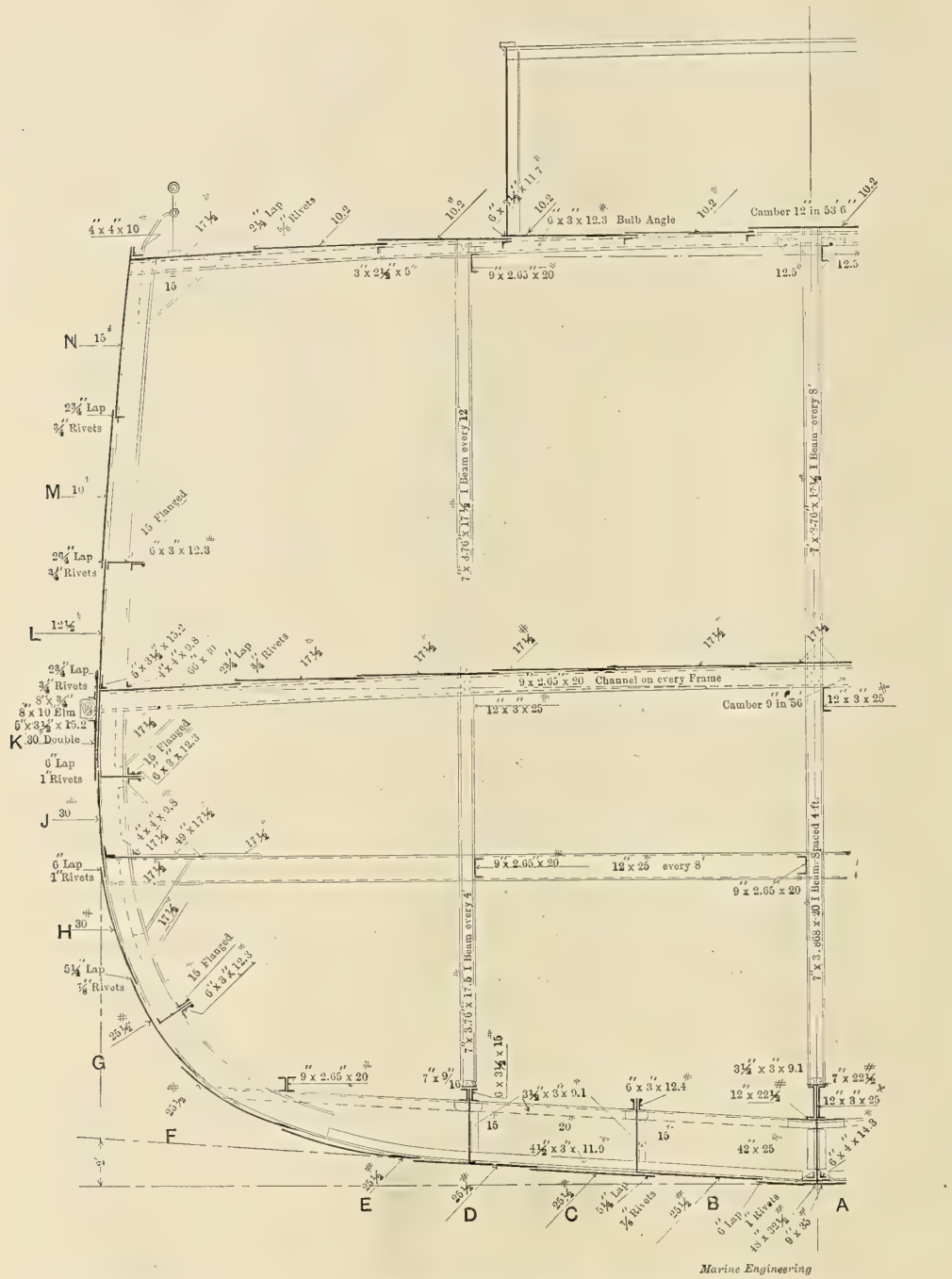
The proposal has been made to introduce the superheating of steam but with this there is some difficulty. In the early turbines of the Parsons system it was found that the composition of the metal forming the blades gave trouble with even a moderate degree of superheat. A change was made which very materially mitigated this difficulty. Shipbuilders, however, are looking with very considerable favor on other systems —among others the Curtis—with the possibility of using a high degree of superheat and the idea has been suggested that a very satisfactory combination would be the Curtis system for the high pressure turbine using superheated steam, with the Parsons for the low pressure turbine. But matters in connection with turbine are very largely in the experimental stage; it is recognized that the next year or two will witness very important developments in this branch of mechanical science.

X.

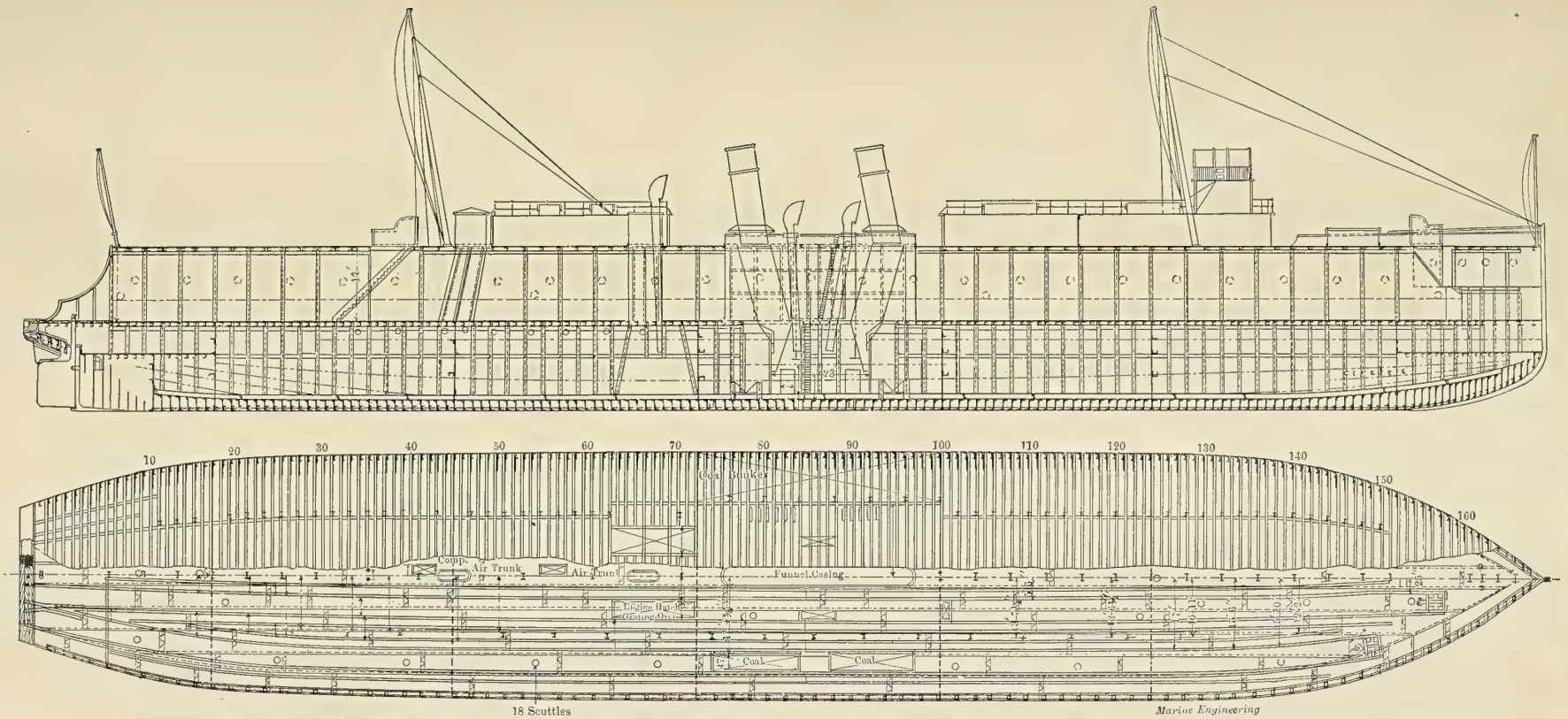
PERE MARQUETTE 19, A CAR FERRY OF THE LARGEST SIZE.

A few years ago there was described in this magazine the big car ferry *Pere Marquette* 17, built to the order of the Pere Marquette Railroad Company, which operates several car ferry lines on the northern waters of Lake Michigan. Increased business has required construction of more vessels, and there have just been completed for this company two large new ships, nearly identical to *No. 17,* except that there are no passenger accommodations, and named *Pere Marquette* 19 and *Pere Marquette 20,* built by the American Shipbuilding Company, Cleveland, Ohio.

The hulls of these ships have to be of extra heavy scantling; first, to sustain the longitudinal and complex strains of supporting a rolling load such as heavy passenger and freight cars; and second, to give strength to withstand the heavy seas and ice encountered on Lake Michigan four or five months of the year. The shape of the hull is of the most approved form, to resist the crushing strains of the heavy ice. By referring to the midship section on this page, it will be seen that

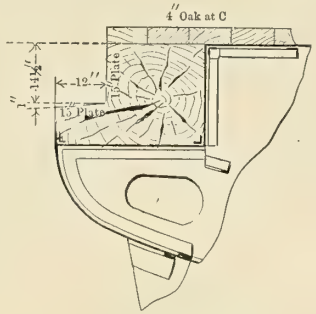


MIDSHIP SECTION OF THE STEEL CAR FERRY PERE MARQUETTE 19 FOR SERVICE ON LAKE MICHIGAN.



LONGITUDINAL AND DECK PLANS OF THE TWIN SCREW STEEL CAR FERRY PERE MARQUETTE 19. LENGTH OVER ALL, 350 FEET; CAPACITY, 4 TRACKS FOR THIRTY FREIGHT CARS.

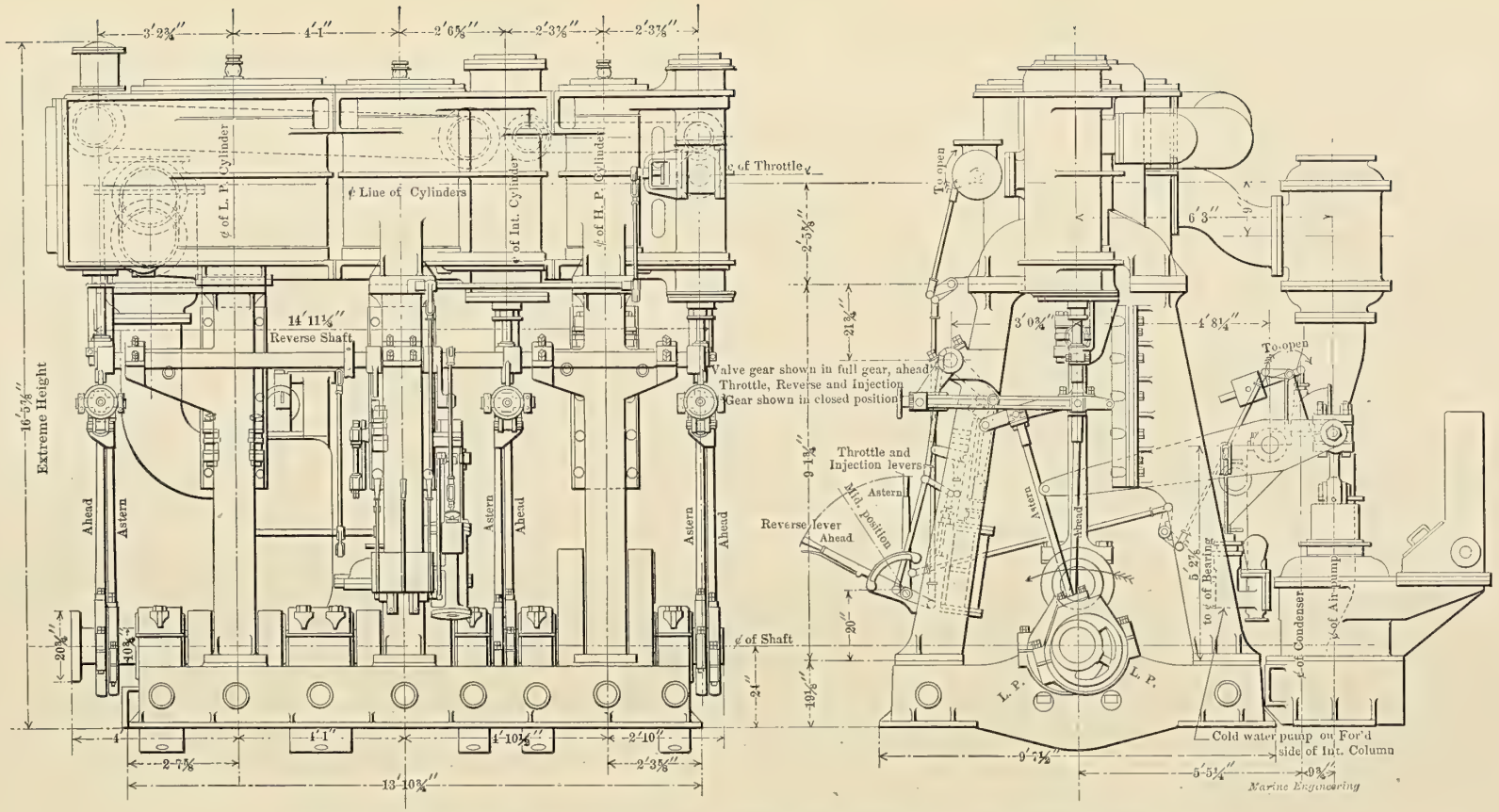
from the bilge up the frames are of heavy channel section and spaced 24 inches, alternate frames extending to the upper deck. The bottom frames are 4 1-2 inches by 11.9-pound angles. The floors are 30 inches deep at the centers and of 20-pound plate, with 3 1-2-inch by 9.1-pound reverse bar at top. They are connected to vertical keelson by double clips and strongly riveted to side frames. The flat plate keel is 48 inches by 32 1-2 pounds; the bottom and bilge strakes of plating 25 1-2 pounds; the upper bilge and side plating up to main deck are 30 pounds, with doubler on the main shear



DETAIL OF STERN POCKET.

strate; the top sides are plated with 12 1-2 and 10-pound plates, while the upper shear strake is of 15 pound.

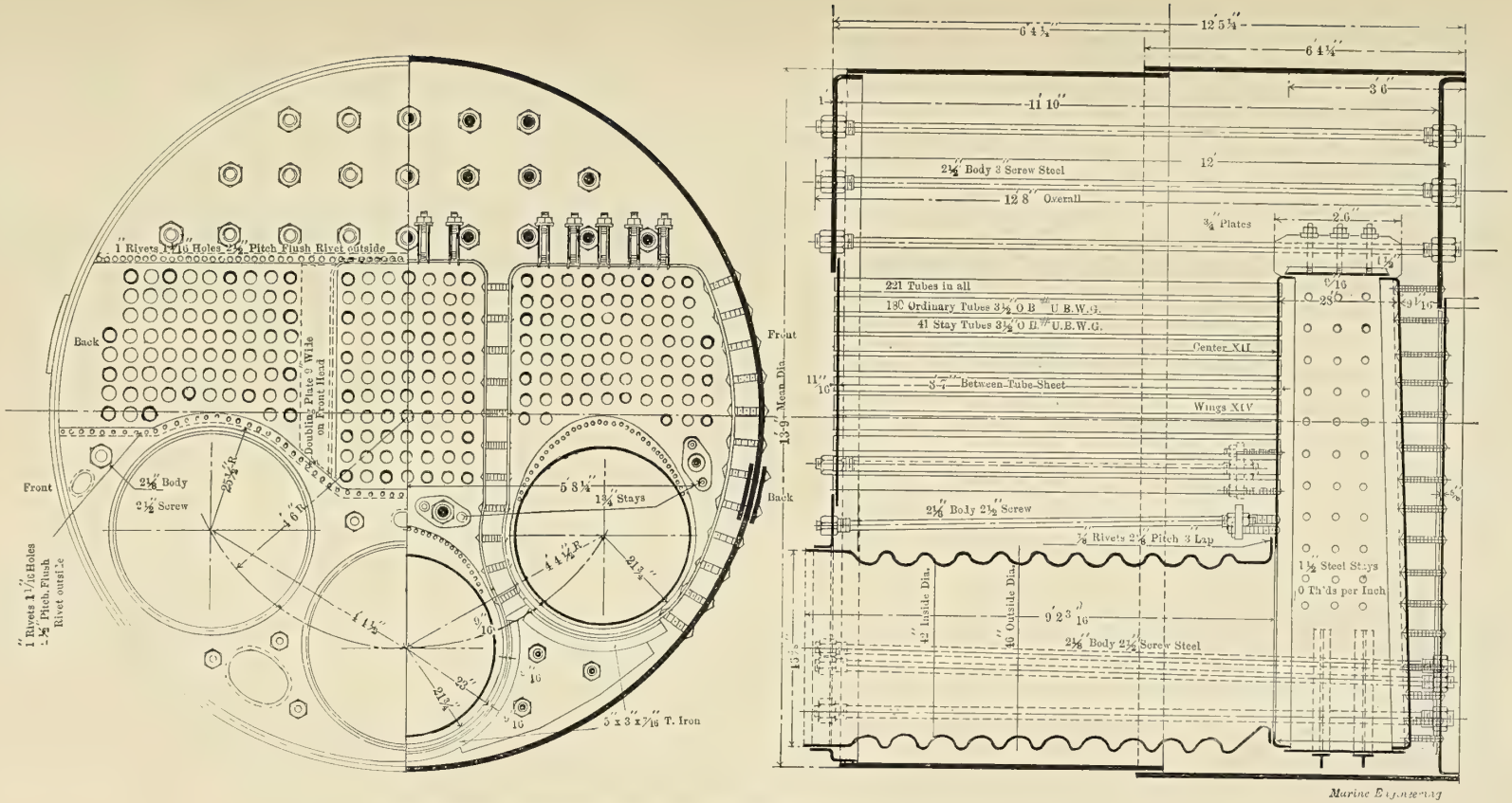
The foundation plates are securely riveted to the top of floors and connected to the center girder by 12-inch channels, and on top of these channels is a rider plate 7 inches by 22 1-2 pounds. Two side keelsons are fitted on each side, made up of intercostal 15-pound plates between floors, flanged to shell plating, the first keelson being topped with 6-inch by 12.3-pound bulb angles, and the other of 6-inch by 15-pound double channels. A heavy keelson made up of 9-inch by 20-pound angles



ONE OF THE THREE-CYLINDER TRIPLE EXPANSION ENGINES FOR THE STEEL CAR FERRY PERE MARQUETTE 19.

runs along the top of floors at intersection of frames. The bilge keelson is made up of intercostal flanged plates and double bulb angles. Side stringers are fitted as shown in the drawing. Channel beams 12 inches deep are spaced every 8 feet and connected to this stringer plate. Another side stringer, similar to the bilge keelson, is worked in between these beams and the main deck. The main deck plating and stringer are carried on channel beams spaced every 24 inches. The stringer is 66 inches by 30 pounds, and the rest of the plating 17 1-2 pounds. The main deck beams are supported by three rows of stanchions of I sections spaced every 4 feet, and to these are riveted continuous fore and aft girders made up of 12-inch channels, 3 lines under the main deck beams, and 3 under the hold beams. The upper deck beams are of bulb angle, and under these at the line of the stringers are erected similar channels fore and after. The center row of stanchions between decks are spaced 8 feet, and the outside rows 12 feet. The upper deck stringer is 17 1-2 pounds, and the rest of the deck 10 pounds.

The stem is heavy forging 11 inches by 4 inches, and the stern post also of the same dimensions. The frames for a space of 30 feet from the stem are heavily reinforced, and the plating is doubled to take the crushing strain when driving the ship into heavy ice. The propeller shafts are inclosed in spectacle framing with



ONE OF THE 4 SINGLE END CYLINDRICAL SCOTCH BOILERS FOR THE PERE MARQUETTE 19.

heavy cast steel brackets at the after end. At the water line is erected a continuous plate stringer 49 inches wide, securely connected to the shell and main frames by heavy angles, and bracketed above and below to the frames.

In the steel house forward are accommodations for captain and officers, and in the after cabin are the messrooms, accommodations for assistant engineers, stewards, watchmen and wheelsmen. The forecastle is located on the main car deck, and above this is a partial deck where is placed a steam windlass, mooring bits, chocks, etc. The firemen's quarters are forward of the boilers below the main deck.

As will be noticed from the drawing, the stern of the vessel is opened for taking cars on board. There are four tracks to accommodate in all 30 freight cars or 14 large passenger coaches. In making dock the ship backs in.

MACHINERY.

The vessel is driven by two sets of triple expansion engines, the diameters of the cylinders being 19, 31, and 52 inches by 36 inches stroke, which are placed entirely below the main deck. To the high- and intermediate-cylinders piston valves are fitted, while a double ported slide valve is on the low-pressure cylinder. All are worked by Stephenson link motion. The crank shaft is built up in one piece, with webs shrunk on, and is 10 3-4 inches in diameter. The air pump for each engine is driven from the intermediate cross head and is 30 inches in diameter by 12 inches stroke. The propellers are 12 feet in diameter by 14 feet pitch, of cast steel made

specially heavy to use in the ice. The air pump for each engine is worked from the intermediate crosshead. As is the custom on the Great Lakes, a jet condenser is used. Steam is supplied at 175 pounds pressure by 4 single-end Scotch boilers, each fitted with 3 furnaces and separate combustion chambers. The diameter of each boiler is 13 feet 9 inches mean, and the length is 12 feet. The other data will be found in the accompanying table and on the drawing of the boiler, page 183. In each boiler are 180 ordinary tubes 3 1-2 inches by 11 B. W. G. and 41 stay tubes, 3 1-2 inches by 7 B. W. G.

In the matter of auxiliary equipment this boat resembles her previous sisters. There are two main duplex compound feed pumps 8 by 12 by 5 by 10 inches, one pony duplex pump 8 by 5 by 10 inches, one duplex sanitary pump 6 by 4 by 6 inches, and one bilge pump 8 by 10 1-4 by 10 inches. The steering engine made by the shipbuilders after their own design has a double 8 by 8 inch engine. The boat is lighted throughout by electricity supplied by two direct connected sets, one of 15 kw. capacity and the other of 4 1-2 kw. The first boat, the Pere Marquette No. 17, was designed by Mr. Robert Logan, naval architect, and the success that it attained in contending with ice and storm, and performing regular service has done much to increase traffic, both freight and passenger, of the company.

MARINE ENGINEERING DATA CARD. APRIL, 1904.

NAME—Pere Marquette 19 and 20. NATIONALITY—American. TYPE—Car ferryboat

LAUNCHED—1903. BUILDER—American Shipbuilding Co. OWNER—Flint and Pere Marquette Railroad Co.

Length over all.....350 ft. 0 ins.
" between perps.....338 " 0 "
Beam, molded.....56 " 0 "
Depth, " to main deck.....19 " 6 "
" " " upper " .....36 " 3 "
Draft, load.....12 " 3 "
Displacement long tons, fresh water....4,010 tons
Capacity.....4 tracks for 30 freight cars

Engines: .....2 sets, triple
Cylinder diameters.....19, 31, 52 ins.
Stroke.....36 ins.
Valves.....Piston on H. P and I. P.
Bed plate, length over all.....13 ft. 10 3-4 ins.
Jet condenser.....
Air pumps....30 ins diameter by 12 ins. stroke
Crank, shafting diameter.....10 3-4 ins.
Thrust, " " 11
Line, " " .....10 1-2 "
Propeller " " .....11 1-2 ins.
Revolutions per minute.....100
I. H. P., both engines.....2,350
Speed.....12.7 knots

Boilers: .....4 single end Scotch
Diameter.....13 ft 9 ins.
Length.....12 " 0 "
Steam pressure.....175 pounds
Furnaces, each.....3 Morrison
Diameter, inside.....42 ins.
Length of grates.....6 ft. 0 "
Tubes, Number 1 boiler.....221
Diameter.....3 1-2 ins.
Length between sheets.....8 ft. 7 "
Area through tubes.....12.73 sq. ft.
H. S., one boiler.....2,103 " "
G. S.....63 " "
Weight of boiler, dry.....75,500 pounds
" " water in boiler.....50,275 "
H. S. ÷ G. S.....33.38
H. S. ÷ I. H. P.....3.58
I. H. P. ÷ G. S.....9.34

Propellers: Number.....two 4 blades
Diameter.....12 ft. 0 ins.
Pitch.....14 " 0 "
Area, developed.....56.2 sq ft
Material.....cast steel

SEA STRENGTH OF THE PRINCIPAL NAVAL POWERS.

ISSUED BY OFFICE OF NAVAL INTELLIGENCE.

NUMBER AND DISPLACEMENT OF WAR-SHIPS, BUILT AND BUILDING, OF 1,000 OR MORE TONS DISPLACEMENT.

TYPE.	Great Britain.				France.				Russia.				Germany.				United States				Italy.				Japan.				Austria.			
	Built.	Tons.	Building.	Tons	Built.	Tons.	Building.	Tons.	Built.	Tons.	Building.	Tons.	Built.	Tons.	Building.	Tons.	Built.	Tons.	Building.	Tons.	Built.	Tons.	Building.	Tons.	Built.	Tons.	Building.	Tons.	Built.	Tons	Building.	Tons.
Battleships, first class*	50	669,000	9	142,600	20	223,621	6	87,800	17	201,129	8	112,864	14	152,581	6	77,962	11	125,129	13	192,700	14	173,276	5	63,155	6	84 300	..	.....	..	.....	3	31,800
Other battleships and coast defence ironclads	6	49,900	..	.....	20	94.615	..	.....	12	66,679	..	.....	16	90,773	..	.....	12	47,945	..	.....	3	12,244	..	.....	2	13,004	..	.....	11	62,480	2	16 720
Armored cruisers	27	262,800	14	166 000	15	113,767	8	91,849	8	71,261	..	.....	3	28.144	3	28,048	2	17,415	8	111 800	5	31 891	1	7.264	8	73,550	..	.....	2	11.520	1	7,400
Protected cruisers, first class (above 6,000 tons)	21	201,950	..	.....	4	31,513	..	.....	6	39,546	3	19 965	..	.....	..	.....	2	14,750	3	28,800	..	.....	..	.....	..	.....	..	.....	..	.....	..	.....
Protected cruisers, second class (3 000 to 6,000 tons)	53	235 880	7	21 000	19	79,752	..	.....	5	19,450	3	9,445	9	46,949	..	.....	15	56,393	4	12,400	5	17,490	..	.....	10	41,226	3	10,095	2	8,128	..	.....
Other cruisers and scouts (above 1,000 tons)	44	96,510	8	21 610	18	32 840	..	.....	11	18,093	..	.....	31	69.427	4	11,715	23	32,773	2	2,170	11	23,937	..	.....	17	31 506	..	.....	6	11,785	..	.....
Totals	201	1,516,040	38	351,210	96	576,108	14	179,649	59	416,158	14	142,274	73	387,874	13	117,745	65	294,405	30	347,870	38	258,838	6	70,419	44	243,586	3	10,095	21	93,913	6	55 920
Combined totals	239 of 1,867,250 tons.				110 of 755,757 tons.				73 of 558,432 tons.				86 of 505,619 tons.				95 of 642,275 tons.				44 of 329,257 tons.				47 of 253,681 tons.				27 of 149,833 tons.			

*Battleships, first class, are of (about) 10,000 tons, or more, displacement, and are not more than 20 years old. The few exceptions as to age have been reconstructed and are given a modern armament.

N B.—Gunboats and other vessels of less than 1,000 tons are not given in the table, nor are transports, despatch vessels, converted merchant vessels, or yachts, or obsolete cruisers. Vessels not begun are not included in the table.

American Society of Mechanical Engineers.

The summer meeting of the American Society of Mechanical Engineers will be held in Chicago beginning on May 31 and continuing till June 3. The meeting is to be a joint session with the Institute of Mechanical Engineers of Great Britain, who have been invited by the former society to partake in this session. Nearly 200 members of the British Institute have expressed their intention of taking part in this meeting.

According to a notice sent out by Mr. F. R. Hutton, Secretary of the American Society, among the subjects of papers to be presented by the British Institute will be: Steam turbine, the gas engine, motor cars, hydraulic and electric cranes, induction fans, garbage destructors. The committee of meetings of the American Society has asked for papers on the American steam turbine, gas engine, power plant of tall office buildings, the American locomotive testing plant, shop management problem, and modern machine tools. It is expected that papers from both Societies will be distributed to American members in advance. Chicago has been selected by reason of the convenience of access to St. Louis, while securing the advantages of comfortable hotels which is practically impossible in an Exposition city.

New Erie Railroad Ferryboats.—Two of the three new steel double-decked screw ferryboats for the Erie Railroad Company have been placed in service. The boats are from designs by Mr. J. W. Millard, naval architect, New York. The *Tuxedo,* the first on the line, was built by the Harlan & Hollingsworth Company, and the *Arlington,* which has just been delivered, came from the yards of the Burlee Dry Dock Company, Staten Island. The boats are 234 feet long over all, 64 feet beam, and 17 feet 9 inches depth of hull. The propelling machinery consists of two compound engines working on a shaft which is continuous from end to end of the boat.

American Shipbuilding.—The Brotherhood of Boiler Makers and Iron Shipbuilders of America has issued an appeal through its president, John McNeill, to the members of Congress, urging the passage of the bill before the House and Senate for the creation of a commission to recommend legislation for the development of the merchant marine. The plea is that as ships cannot be built in the United States as cheaply as in foreign lands, largely because of the increased wages received in this country, that the government should protect the laborer against the free competition of foreign ships.

Alcohol for Industrial Purposes.—The use of alcohol in the arts has been the subject of much investigation and experiment abroad, and several different forms of alcohol motors have been brought out. At present there is a bill before Congress, providing that denaturized alcohol, which is not fit for drinking purposes, shall be exempt from taxation. Many years ago such legislation was enacted in Germany, which resulted in the extensive use of alcohol for industrial purposes. With a view of reducing the price of alcohol for industrial or chemical purposes by removing the import duty upon it, the Russian government has offered a prize of about $25,000 to the person, whether Russian or foreigner, who discovers a denaturizing substance, such as shall fill the requirements of making it undrinkable, yet at the same time not destroying any of its chemical or thermal reactions.

Meeting of Institute of Naval Architects.

The Annual Meeting of the Institute of Naval Architects of Great Britain will be held in the Hall of the Society of Arts, John street, Adelphi, London, W. C., on March 23 to 25 inclusive. The following papers will be presented and discussed:

1. *The Battleships Triumph and Swiftsure (ex-Chilian Libertad and Constitucion).*" By Sir Edward Reed, Vice-President.
2. *Merchant Cruisers and Steamship Subsidies.* By the Right Hon. Lord Brassey, Past President.
3. *On the Establishment of an Experimental Tank for Research Work on Fluid Resistance.* By Sir William H. White, Vice-President.
4. *Some Results of Model Experiments.* By R. E. Froude, Member of Council.
5. *On the Heeling and Rolling of Ships of Small Initial Stability.* By Professor A. Scribanti, R.Ital.N.R., Member.
6. *Gyroscopic Effect of Fly Wheels on Board Ship.* By Herr Otto Schlick, Member.
7. *Some Advantages of Gas and Oil Engines for Marine Purposes.* By J. E. Thornycroft, Associate.
8. *Internal Combustion Engines for Propelling Small Vessels.* By A. F. Evans, Visitor.
9. *Steam Turbine Propulsion for Marine Purposes.* By Professor A. Rateau, of Paris.
10. *Some Points in Connection with the Transverse Sterngth of Ships.* By J. Bruhn, Member.
11. *Normal Pressures on Thin Moving Plates.* By A. W. Johns, Visitor.
12. *Ships' Composition.* By A. C. A. Holzapfel, Associate.
13. *Fire Prevention on Ship Board.* By Edwin O. Sachs, Associate.

Lackawanna Railroad's New Ferryboats.—The contract has been awarded to the Newport News Shipbuilding & Dry-Dock Company, Newport News, Va., by the Lackawanna Railway for four large steel screw double-decked ferryboats for the railroad company's new Twenty-third street ferry, New York. The boats will have a length of 231 feet, a beam of 62 feet over all, and a draft of 10 feet 6 inches. Two sets of compound engines, developing 1,400 I. H. P. are to be installed furnished with steam by two Scotch boilers. The designed speed is to be 14 miles. The general finish of the interior is to be colonial with mahogany seats, stairs, and moldings. The boats will be heated and ventilated by an indirect hot air system. The floors of both upper and lower cabin will be laid in rubber tiling. Each boat is to have a capacity of a thousand passengers. The plans have been furnished by Gardner & Cox, 1 Broadway, New York, N. Y., working in consultation with Col. E. A. Stevens of Hoboken.

Government Supplies in American Ships.—The Senate has passed a bill requiring the transportation of Government supplies in American ships. The provisions of the bill are as follows: "That vessels of the United States, or belonging to the United States, and no others, shall be employed in the transportation by sea of coal, provisions, fodder or supplies of any description, purchased pursuant to law, for the use of the army or navy, unless the President shall find that the rates of freight charges by said vessels are excessive and unreasonable, in which case the contracts shall be made under the law as it now exists; provided, that no greater charges be made by the vessels for transportation of articles for use of the said army and navy than are made by such vessels for transportation of like goods for private parties or companies. This act shall take effect sixty days after its passage."

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE past year has not been one which the American shipbuilder is likely to look back on with any special feelings of satisfaction. The past, however, belongs to itself and should only merit consideration from the shipbuilder and engineer as he may be able to draw therefrom wise lessons for his future guidance. The modern captain of industry must have his face set steadfastly to the future and, avoiding the mistakes of the past, must look forward to the "coming season" as the arena of his industrial campaign. What then does the coming year hold of promise for the American shipbuilder and marine engineer? Are there discernible prospects of a revival of activity in the shipbuilding interests, and if so, where are they to be sought? The gift of prophecy is one rarely met with in the present age, and we shall not attempt more than the mention of a few points which may have some bearing on the questions of such vital interest to American shipping.

First a word as to the function of new legislation in the development of prosperous maritime conditions. We may admit freely that there is unquestionably sore need for legislation more perfectly adapted to the demands and conditions of the present day, and which shall, so far as legislation can, give to the shipping interests a just balance of opportunity with reference to both the world as a stage of activity, and American industries as affecting our own national status and development.

It is obviously unfair to expect that the shipping interests, viewed from the standpoint of internal national development alone, shall be made the beneficiary of selective legislation at the expense of other national industries. It is likewise unfair to expect that an industry, which must necessarily take the whole world as a stage, can find an equal chance in the world competition if restricted by legislation which takes no cognizance of international relations and economic conditions, and which has reference to domestic development and internal economy alone.

Between these two horns of the dilemma our shipping interests have long suffered, while it seems clear that some wise compromise might be worked out, and that some legislation might be devised which should give to these interests a fair measure of opportunity in the world competition, without at the same time giving them an unfair advantage with relation to the other internal interests. What the details of such legislation should be we shall not attempt to determine at the present moment, but we do believe that these general views are becoming more clearly understood both by the law makers and by the American people at large, and that the day is not far distant when these subjects will begin to receive the attentive study which they deserve, and that some measure of legislative relief will be found which shall help the shipping interests where they need help, and without unfairness to other forms of domestic industry.

With this faith, however, we must not forget that no amount of legislation can direct capital into a channel which is not attractive and promising as an investment. Capital always seeks the field which will yield the largest and surest returns, and it is an unquestioned fact that during the period of industrial development and expansion since the close of the Civil War, the demand for capital in domestic commerce and industry has been so great and the returns have been so much larger than could be expected from investment in foreign commerce and shipping, that there has been but small extra capital for such ventures and

but small inducement to investors in such fields. There are indications of a change here. The development of internal industries has its limit unless a world market is sought, and the world's markets can not be entered on a basis of successful competition without some share of control in the world's carrying trade and shipping interests. Again, wonderful as our internal development has been during the past forty years, it hardly seems likely that for the future this class of interest can absorb so large a share of available capital to the exclusion of international commerce and shipping. If we mistake not, the trend of the age is toward a share of activity in the world's business at large, and this means more American ships and shipping as a necessary means to the end. As for the present depression, the pendulum between over and under production is always swinging one way or the other. Just now we have reached a point where the fresh demand is small, and the production in the immediate past is adequate. But just as surely as the pendulum has thus swung to and fro in the past, so surely may we look in the future for tendencies in the direction of fresh orders and increasing demand. How soon these conditions may reach us we may not attempt to say, but the present condition should only be looked on as temporary and due to special and local causes which time and new conditions will speedily remove.

Again, having in view the prospect of work on the Panama Canal and the assured policy of the Government to maintain its navy and its place as a world power, together with the general assurance that as a nation we are not growing poorer but richer, and that the same causes which in the past have given prosperous times for shipbuilders and owners are still in operation; these various facts, with others as mentioned above, all give ground for hope, and we confidently look for a future development of American shipping and commerce which shall far exceed the modest expectations which at the present time we may be justified in forming from the immediate outlook.

At last the plans for a united engineering building in New York city for the accommodation of the leading engineering societies have been definitely decided upon and it is expected that work on the new building will be taken up at once. Several months ago Mr. Andrew Carnegie addressed a letter to the American Society of Civil Engineers, American Society of Mechanical Engineers, Institute of Mining Engineers, Institute of Electrical Engineers, and the Engineers' Club of New York, stating that he would place at their disposal one and a half million dollars for the erection of a united engineering building to accommodate the different societies. These plans have already been discussed in previous issues of this magazine, and suffice it to add that the great advantages to the constituent societies resulting from this munificent gift would be, in the erection of a splendid building especially designed to fill the requirements of all the societies in providing adequate auditoriums, library and lecture rooms, and a reduction in the operating expenses of each society, thereby permitting the funds to be of more direct benefit to the members, such as, carrying on scientific research. No society, however, will lose its individuality, for it was not the intention to amalgamate the different institutions themselves.

The question of the acceptance of Mr. Carnegie's gift was voted on at once by the membership in all the societies, except the civil engineers, and, as was to be expected, an overwhelming vote in the affirmative was recorded. The vote of the civils has but recently been reported, and stood 1,139 to 662 against the proposition. Fortunately, however, their action will not defeat the proposition for Mr. Carnegie has repeated his offer to the four other societies.

Some of the smaller technical societies have, we understand, applied for accommodation in this projected building, and it is stated that the plans will provide for office and meeting room space to accommodate these societies. This will, indeed, be a great boon to thus assist those societies which have not the financial strength of the larger ones. Among those which have applied to the general committee is the Society of Naval Architects and Marine Engineers. This society, organized ten years ago, has carried on splendid work, and brought out much valuable engineering data before the profession. Its numerical and financial growth has been slow, but increasing each year, and the time apparently has at last arrived when it may occupy permanent quarters.

The strengthening of the societies, which will follow the opening of this splendid building, will be of very great value to the profession generally. Mr. Carnegie has always been a friend of the engineers, and in thus dedicating a building to the profession he acknowledges the great service the profession has rendered him in his life's work.

Care of Boilers.

Editor Marine Engineering:

I read with great interest "Old Scotch's Reverie," by C. A. McAllister, U. S. R. C. S., in your issue of March. It is instructive and amusing and, in my judgment, is the best article ever written on the subject. Could a copy be placed in every engineer's hands in the world, it would be worth millions of dollars to steamship owners. The money-earning value of steam boilers depends upon their being properly arranged for cleaning, as well as for the consumption of fuel.

In the early days of the surface condenser there was much trouble with galvanic action in boilers; in several cases the boilers were in three years so badly affected with this trouble that they had to be taken out of the vessels. In 1870 the Old Dominion Steamship Company had a steamer built by the Harland & Hollingworth Company of Wilmington, Del., named the *Wyanoke* and her engine was fitted with a surface condenser, the first in the line. After running about six or eight months, the braces and rivet heads in the shells of the boilers were found to be seriously affected, many of the rivet heads wasted away, and some of the braces scored a quarter of an inch in depth. We cleaned and painted, but still the trouble continued.

Talking about these troubles to Mr. Henry Leveret, constructing engineer for Mr. John Roach of the Morgan Iron Works, he informed me that the French engineers running between New York and Havre, France, used sal-soda in their boilers. This we gave a trial with fairly good results, but the trouble continued more or less. The late Henry G. Hill, chief engineer of the ship, spoke to W. W. Wood, chief engineer, U. S. N., about our troubles with the *Wyanoke's* boilers, and Mr. Wood advised us to use cast zinc plates in our boilers, with the sal-soda. It absolutely stopped all our trouble, and we were a happy lot of engineers. This practice I used for thirty years in all of the company's steamers fitted with the surface condenser and with satisfactory results.

In 1872 the steamer *Old Dominion,* following the *Wyanoke,* ran nineteen years before her boilers needed retubing, she is running at this date with the same boilers she started with thirty-two years ago; however, I have learned, that during this last winter she had had her furnaces and tube heads renewed. This steamer has run more miles than any steamer in the world.

We have engineers at this date who do not know any better than to claim that the expenditure for zinc in boilers is useless, as they would do just as well without it; I would advise them to read "Old Scotch's Reverie."

Geo. V. Sloat.

San Francisco Technical School.

Editor Marine Engineering:

In this day of technical education, San Francisco has not been behind her sister cities in taking up the burden of caring for the needs of the great working classes. San Francisco is to-day, through her natural facilities, one of the foremost ports of the world. The opening of the Isthmian canal will place her in the front rank of the world's maritime cities.

San Francisco early learned the value of training those who "go down to the sea in ships." As far back as I can remember there was a weather-beaten sign by the old Fourth street bridge advertising a night school in navigation and seamanship for seamen who study for examinations for licenses.

The first class in naval architecture was established under the auspices of the Mechanics' Institute in 1895 by a draftsman in one of our leading shipbuilding firms and a graduate of our state university. This class was quite successful and well attended.

In 1897 the board of education was persuaded to start a class of mechanical drawing in a room of the Polytechnic High School. This class of 35 students grew so rapidly that it was removed to the basement of the Humbolt school. It is now known as the Drawing Department of the Humbolt Evening School. To-day, without advertisement of any kind, there are 375 students on the roll. Eleven instructors are employed, giving instruction to the following classes: Two naval architecture, one marine engineering, one electrical engineering, one mining and mill work, one architecture, two miscellaneous mechanical work, one mathematics, one chemistry and physics.

The instructors are young men having practical experience in the branches they teach, working in our principal engineering firms by day and teaching apprentices from the same shops by night. Thus problems which come up during the work of the day can be discussed in the class at night, and so employer as well as employee gets the benefit. The teachers are well acquainted with engineering conditions. It is their aim to give personal instruction; to make the pupil the personal friend of his instructor, giving him another incentive for work. It is an inspiration to attend these classes of bright and earnest young men. It is no easy thing for these men to teach and study after a hard day's work, therefore they should be encouraged.

So large has this work grown that the present quarters are inadequate, there being 53 applicants now awaiting vacancies. The board of education is to erect a new polytechnic school; the upper floor and attic are to be used to accommodate these classes. The Humbolt Drawing Class will then be known as the San Francisco Evening Technical School and will accommodate 600 pupils. Additional classes in marine and electrical engineering and architecture will be formed, and new classes in structural engineering, special and automatic machinery, gas-engine construction, and hydraulics. It is proposed to establish a good technical library and working model room where students may see the various processes in the different trades.

Wm. Decker.

PERSONALS.

W. Carlisle Wallace, formerly of Sheffield, has been appointed the American representative of John Brown & Company, Ltd., Sheffield, England, and opened offices at 22 Thames street, New York, N. Y.

L. Williams has been appointed chief refrigerating engineer of the United Fruit Company, Boston, Mass. Mr. Williams was formerly general manager of the American-Linde Refrigerating Company.

Chas. Lang, who has been connected with the engineering, purchasing, and sales departments of the Wheeler Condenser & Engineering Company, for the

past nine years, has resigned and is taking a much needed rest. He is now considering several offers.

Erwin S. Cooley has accepted a position with the Turbine department of the General Electric Company, Lynn, Mass. Mr. Cooley was formerly with the Buffalo Forge Company and the Newport News Shipbuilding and Dry-Dock Company.

OBITUARY.

Russell W. Davenport, general manager of the Wm. Cramp & Sons' Ship and Engine Building Company, died in Philadelphia, March 2, 55 years of age. Mr. Davenport, who was a Yale graduate, at one time was with the Midvale Steel Company and later was general manager of the Bethlehem Steel Works. He was considered an authority upon the manufacture of steel, especially of guns and armor plate.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of March 9, 1904, the following degree of completion of vessels building for the United States Navy:

			Degree of Completion. Per Cent.	
BATTLESHIPS.			Feb. 1.	Mar. 1.
Ohio	18 knots.	Union Iron Works	85.5	88
Virginia	19 "	Newport News Co	53.8	55
Nebraska	19 "	Moran Brothers Co.	37.7	41.6
Georgia	19 "	Bath Iron Works	45.4	47.6
New Jersey	19 "	Fore River S. and E. Co	50.3	52.1
Rhode Island	19 "	Fore River S. and E. Co.	51.7	54
Connecticut	18 "	Navy Yard, New York, N. Y.	28.5	30.86
Louisiana	18 "	Newport News Co.	37.55	40.56
Vermont	18 "	Fore River S. and E. Co.	3.6	4.6
Kansas	18 "	New York Shipbuilding Co.	3.9	5.2
Minnesota	18 "	Newport News Co	14.73	18.29
Mississippi	17 "	Wm. Cramp and Sons	0.	0
Idaho	17 "	Wm. Cramp and Sons	0.	0
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	66.8	68.6
West Virginia	22 "	Newport News Co.	73.32	76.76
California	22 "	Union Iron Works	54	56.5
Colorado	22 "	William Cramp and Sons	71.8	73
Maryland	22 "	Newport News Co	69.15	71.22
South Dakota	22 "	Union Iron Works	50	52.5
Tennessee	22 "	William Cramp and Sons	16.6	19.5
Washington	22 "	New York S. B. Co.	13.9	17
PROTECTED CRUISERS.				
Denver	17 knots.	Neafie and Levy	98	98
Des Moines	16½ "	Fore River S. and E. Co.	99	99.5
Chattanooga	16½ "	Lewis Nixon	72	72.6
Galveston	16½ "	Wm. R. Trigg Co	72	73.5
St. Louis	22 "	Neafie and Levy	37.9	38
Milwaukee	22 "	Union Iron Works	42.5	44.5
Charleston	22 "	Newport News Co.	60	64.5
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	22.2	29.1
Paducah	12 "	Gas Engine and Power Co.	25	25.5
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	25.5	26
Intrepid	"	Navy Yard, Mare Island	7	9
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	10	20
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	93	93
Goldsborough	30 "	Wolff and Zwicker	99	99
Blakely	26 "	George Lawley and Son	99	99
Nicholson	26 "	Lewis Nixon	99	99
O'Brien	26 "	Lewis Nixon	98	98

QUERIES AND ANSWERS.

Q. 198.—Will you please answer the following question upon the stability of ships:

Why should the center of support be taken at the same point as the center of gravity of the volume displaced in a floating boat?

In the accompanying figure all pressures pass through the center of the cylinder and hence also the resultant. According to theory, the resultant pressure comes from the center of gravity of the water displaced, *S*. J. P. B.

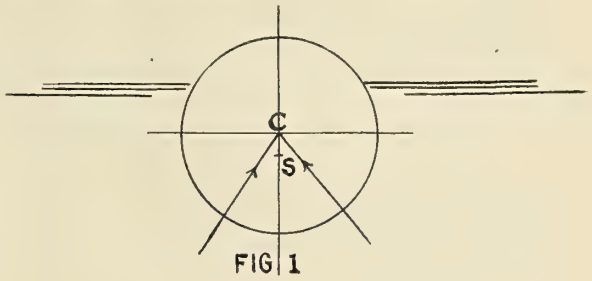


FIG. 1

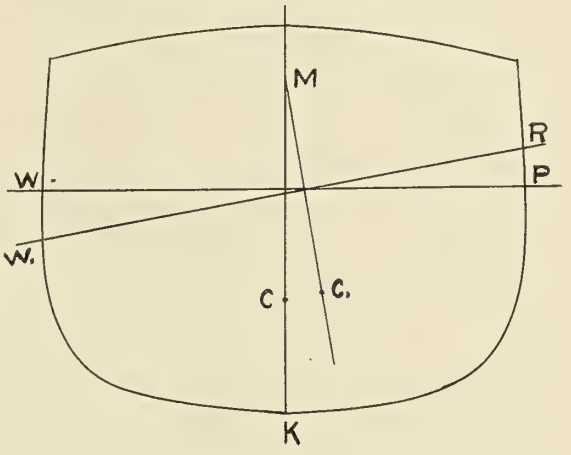


FIG. 2.

A.—There seems to be here some uncertainty in the use of the terms center of support and center of gravity of volume displaced. It is perfectly correct that with a body of the form shown, all surface pressures pass through the point *C*, and it is equally true that this point *C* is the point or center of support, so far as that term has meaning when applied to a floating body. The facts are briefly as follows:

In the case of any floating body as in the figure, with water plane at *W P*, the vertical resultant of all the individual supporting forces which act on the surface will of course be vertical and will act on a line drawn vertically through some point *C*, the center of gravity of the displaced volume *W K P*.

This statement does not fix the point of application of the supporting forces at the point *C*, but simply asserts that it will act along a vertical line passing through this point. Similarly if $W_1 P_1$ is a second water plane corresponding to a slight inclination to the original position, then in such position the resultant of the supporting forces will lie on a vertical line drawn through some point C_1 adjacent to *C* and found as the center of gravity of the displaced volume $W_1 K P_1$. Now if the second

position is very near the first the two lines through *C* and *C*, will be nearly parallel and will intersect at some point *M* which, as may be shown by higher mathematics, will be practically stationary for any position of the ship very near the original one, or differing only by four or five degrees. Or to put the matter more definitely, suppose the ship starting in the condition shown with water plane at *W P*, is inclined in both directions to the following angles: 1° 2° 3° 4° 5°. Then it would be found that all of the lines of support drawn through the points similar to *C* would pass practically through a single point *M*. This point is known as the metacenter and is the real point of support. In other words if we suppose the ship to roll back and forth about the first position through a small angle, the varying line of support will pass constantly through or indefinitely near to *M*, which thus becomes a force center or point of support for the ship in this position. If the angle of heel is greater, as 15 or 20 degrees, the line of support will usually not pass through *M*, but will shift to one side or the other. Still for such an inclination as 20 degrees there will be another point which will be a force center or point of support for this position, and through which the lines of support would pass for very slight changes of inclination on either side of the 20 degrees point.

It thus appears that the metacenter is the point of support and not the center of buoyancy or center of gravity of the displaced volume.

It is true that the latter is often spoken of as though it were a force center, but such language is inexact, and in reality it is the metacenter, as above stated, that really constitutes the point of virtual support. In the case of the body which you mention the metacenter remains constantly at the center *C*, and therefore this point remains constantly the point of virtual support.

In the general problem of the equilibrim of a floating body the centers of buoyancy and the curve which they build up as the ship is heeled through successive angular positions, are of great importance and are made the subject of extended investigaition. They serve, however, only as an intermediate step in the examination of the problem, and the real question of equilibrim is determined by the center of gravity of the ship and the relative location of the metacenter as defined above.

Q. 199.—Would you please give me your advice on the following and decide which is right? Description of engine: Vertical fore-and-aft compound, surface condensing; cranks at angle of 90 degrees; L. P. engine following the H. P. engine; size of engine, 14 inches by 28 inches by 22 inches stroke; boiler pressure per gauge, 108 pounds; vacuum per gauge, 24 inches; receiver, 3.5 times the capacity of H. P. engine; revolutions per minute, 136 (full speed); pitch of wheel, 8 feet 6 inches; H. P. engine, cut-off at 12 inches from head end and 11 1-2 from crank head; L. P. engine, cut-off at 20 inches from head end and 18 1-2 from crank end. At full speed receiver shows only 2 pounds by gauge or 17 pounds absolute, and at 110 revolutions about 14 pounds absolute; from cards taken the H. P. engine shows about 1-3 more H. P. than the L. P. engine, and at 110 revolutions it is twice as much.

M. K. maintains that by carrying the cut-off so far on the low that all the power is utilized, but if the cut-off were earlier it would be at a loss of power as a whole. He also maintains that the larger the receiver the better.

I say that the power as a whole is not affected by the L. P. being cut off early or late, but that an earlier cut-off on the L. P. will put more power on the L. P. engine and less on the H. P. engine. I also maintain that the receiver is too large and would be better if reduced to twice the cubic contents of H. P. engine at the time of cut-off.

What cut-off would you advise on the L. P. engine to equalize the power (at 136 revolutions) if we allow 8 pounds loss of pressure from boiler to H. P. engine, viz.: 100 pounds per gauge, supposing the H. P. engine to remain at 12 inches cut-off (that is all the boiler will supply when wide open) or what would you suggest to get the best results? L. W.

A.—You are quite correct in your claim that a change in the cut-off on the L. P. cylinder will not affect the total power developed but only the distribution of power between the H. P. and L. P. cylinders. This may be seen more clearly by remembering that in a general way the total amount of work developed in the engine will be determined by the amount of steam which enters the H. P. cylinder, and this will be determined by the H. P. cut-off only, and will not be affected by the L. P. cut-off. Or put in other words, the L. P. cut-off can not affect the total power developed, because it does not affect the amount of steam which is admitted to the engine. On the other hand the point of L. P. cut-off will affect the pressure at which cut-off takes place, and hence the back pressure in the H. P. cylinder; in general the earlier the L. P. cut-off the higher the pressure, and the later the cut-off the lower. Hence the earlier the cut-off the greater the back pressure in the H. P. cylinder, and the less, therefore, the power developed in this cylinder, while the more will be developed in the low. On the other hand the later the L. P. cut-off the lower the back pressure in the H. P., the greater the power developed in this cylinder, and the less the power in the L. P.

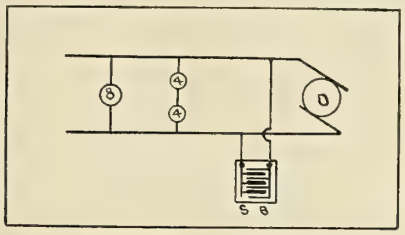
In the case which you mention the cut-off of L. P. is at 19 1-4 inches on the average, or 7-8 stroke. This is so late as to insure the development of much more than half the power in the H. P. and much less than half in the L. P. These conclusions are borne out by the receiver pressures which are much lower than they should be. In order to even matters up, the L. P. cut-off should be brought back to about 15 inches or 70 per cent. on the average. As nearly as the point can be determined by estimate, this should approximately even up the power in the cylinders.

Regarding the receiver, a volume of 3.5 times the H. P. cylinder is unnecessarily large and the results would probably be somewhat better with decreased size, though the actual performance of the engine varies only slightly for a considerable variation in receiver volume. The change most simply made, and most clearly indicated by your data, is to cut-off earlier in the L. P. cylinder, and probably all needful adjustment of power may be made without difficulty by a suitable location of this point.

Q. 200.—I have trouble with the hammer sparker of my gas engine and would like to be advised concerning a better form of igniter. I want a few lights on my boat, say an 8 C. P. hung over the motor and a couple of 4 C. P. lights in the cabin. Also would like to have a small searchlight. Will you please tell me what the best arrangement for this outfit will be. The muffler on my engine is not satisfactory, and I would like to know the best proportions to make the new one.

A.—We would recommend a jump spark igniter for your engine, as there are no moving parts inside of the cylinder, and you will find that by advancing the lead you can get more speed and power out of your motor.

Two 4 C. P. lamps of 6 volts each can be run in series and these two in multiple with an 8 C. P. lamp of 12 volts. In the sketch, *D* is the dynamo, *SB* the storage battery, 4,4 the two 4 C. P. lamps in series and 8 is the 8 C. P. lamp in multiple with the two 4 C. P. For a searchlight, we would recommend the use of acetylene, which gas could also be used in lighting your cabin in place of the three electric lights.



For your boat use a muffler of about five times the cubic capacity of the cylinder and if possible pipe the cooling water from the engine into the pipe leading to the muffler and provide a drain pipe from the lowest point of the muffler. The water condenses the hot exhaust gases and aids materially in muffling.

Q. 201.—Will you please tell me if the stern posts of ocean ships do not become magnetized? While a boy I was in one of the old shipyards on the Atlantic coast and, if my memory serves me right, the stern posts of ships coming in for repair were found to be highly magnetized.

A.—If your boyhood does not carry you back beyond the time of steel ships our observation was correct, for the stern posts and propellers of many ships do become electrified. The conditions are much like those of an electric battery, the steel stern posts and hull forming one electrode, the bronze propeller blades the other, and the salt water the solution of the battery. As the propeller is the positive terminal and the ship the negative terminal, the current flows from the ship to the propeller, causing the pitting of the steel hull. In order to overcome this galvanic action, most ships have zinc plates fitted, in single screw ships to the after face of the stern posts, and in twin screw ships fitted round the after propeller bracket. This does not eliminate galvanic action but such action takes place between the propeller blades and the zinc plates instead of propeller blades and the steel plates.

Q. 202.—Will you kindly advise me through your columns regarding the following:

A. Why is not the "jump spark" system of ignition, which is so popular among automobile builders, more used in gasoline marine motors?

B. In what essential features should a four-cycle, double cylinder, marine motor of 6 to 10 H. P. vary from the typical vertical automobile motor? The motor is to be used in a cruising launch.

C. In a four-cycle marine motor of the above type and size, to develop its rated power at 400 or 500 R. P. M., what is a good ratio of clearance to piston displacement, cylinder diameter to stroke, stroke to length of connecting rod? D. W. L.

A.—The jump spark has not been used for marine motors, owing to the fact that the spark plugs as first constructed were improperly insulated and most of them absorb moisture and short circuit, giving no spark at the points.

Now there are plugs with stone, mica and glazed porcelain that give good results for marine motor use.

You can now obtain jump spark coils that are thoroughly waterproof and by using rubber-covered wire for the leads you will find the jump spark preferable to the hammer break, as it is so easy to advance the lead and increase the revolutions of the motor, also the boat speed.

B.—A four-cycle, double cylinder marine motor need not vary from the typical automobile motor except in the arms or projections by which it is suspended, and some styles of automobile motors can be set in a boat without any change.

C.—A 5 by 5 inch double cylinder, four cycle, will give 10 I. H. P. at 500 R. P. M. This will give 7 1-2 to 8 H. P. on the brake. We would advise running this size engine up to 720 R. P. M., if the ports and valves are correctly designed. This will give 14 I. H. P. and 10 1-2 to 11 1-4 H. P. on the brake.

The combustion chamber contents should be 25 per cent. of the piston displacement. For marine work it is usual to make the bore and stroke equal. It has been found in stationary gas engine practice that making the stroke one and one-half times the bore gives the best results for economy of fuel.

The connecting rod should be twice the length of the stroke for marine use, the longer it is the less side thrust of the piston on the cylinder walls there is, but it is usually made as stated so as to get as short an engine as possible.

Q. 204.—We have recently had considerable discussion with some local parties about two-furnace Scotch marine boilers. These boilers were 12 feet in diameter, designed by their engineer, made of 1-inch plate and each one contained two 50-inch furnaces and had double combustion chambers. The double combustion chambers and large furnaces involved boilers which, to our mind, were larger than there was any necessity for, and by making the furnaces 46 inches in diameter and with a single combustion chamber, we cut the boilers down to 11 feet 6 inches diameter, making them of 15-16-inch plate, saving them considerable in first cost. Our argument was that their double combustion chamber, when there were two boilers, was without any logical grounds for preference over a single combustion chamber; in fact, we maintained that two-furnace boilers, unless there were but one in a boat, were almost invariably constructed with single combustion chamber. The advantages of the single combustion chamber which we presented were the facts that by stoking the fires alternately, very much better combustion was assured, as the volatile gases from the new fire were met by the hot flame in the other combustion chamber and were partially consumed. Their chief argument against a single combustion chamber was that in firing, the cold air admitted by the firing door was distributed all through the boiler, instead of through one-half of it. This seemed to us to be a ridiculous argument, for the reason that only a given quantity of cold air could enter in the brief period the door was open, and the effects of this might better be distributed through all the tubes than half of them. They claimed that their preference for a divided combustion chamber was sustained by nearly all recent engineering practice. Will you kindly have your expert look over the various phases of this question and advise us as to the standing of the contention in reference to the most modern and accepted practice? W. H. C.

A.—You have raised a question over which there is considerable discussion, and the practice seems to be fairly equally divided. There are certain instances where the separate combustion chamber is preferable from an operating point of view, and others where it makes little difference, and therefore the single combustion chamber is to be preferred owing to less first cost. From the operating point of view, the chief consideration is draft. If it is necessary to fire the furnace very often, such as when running on forced draft

and at a high rate of combustion, the separate chamber is to be preferred. Of course every time that the furnace door is opened the draft is checked and the steaming capacity decreased. Now, if it is necessary to fire four times an hour, and you have but one combustion chamber, the draft will be checked eight times during the hour, and the draft must be shut off from each of the two furnaces whenever one of them is opened. This is bad practice because it always takes a minute or so for the fire to get drawing properly after the draft has been checked and turned on. As far as the fact of the cold air striking the tubes is concerned, it is always bad and the less you have of it the better, and with separate combustion chambers each tube will be subjected to the cold draft only half as much as with the single chamber. Your contention that the combustion is improved with the single chamber owing to the partially consumed gases from the freshly fired grate being mixed with the gases from the full fire, is a good one.

Summing up the conditions for two-furnace Scotch boilers, we find that the general practice is to use separate combustion chambers where forced or induced draft is installed and single chambers largely from reasons of decreased weight, first cost, etc., where natural draft is installed.

Q. 205.—Will you advise me from which fuel the most power may be obtained, kerosene or gasoline? S.

A.—The heating value of a fuel, which is what we understand you mean by "power," is stated in thermal units and that unit which is generally used in the British thermal unit (B. T. U.) which is the amount of heat required to raise the temperature of one pound of water at 39 degrees Fahrenheit, one degree Fahrenheit. The heating value of gasoline and its vapor is given as 21,900 B. T. U. and that of kerosene 27,500 B. T. U.

Q. 206.—Will you please inform me what the ratio between the evaporating surface and the production per day of a modern evaporator in actual practice is? D. C.

A.—This is a very difficult question to answer, for, in the first place, the conditions under which the evaporator is to run altogether govern this factor of heating surface, and, unless you specify more definitely it is impossible to come anywhere near the probable figure; and, secondly, different makers do not agree on the amount of surface for similar conditions. Evaporators are made in single, double, and triple effect, and in some cases quadruple effects are used. In these vapor from a high pressure is led to a second evaporator and used to evaporate the water in the second effect; similarly, its vapor is led to the third effect, and so on. The conditions of the heating surface, whether or not the tubes are scaly or whether there is a deposit of salt on them, etc., governs the amount of water evaported.

In the navy type of evaporator, which is used on many of the new government ships, one square foot of surface is credited with evaporating 20 gallons of water in twenty-four hours with steam pressure at 120 pounds and the evaporators connected singly. Thus, in the specifications for the battleship *Virginia*, three evaporators are called for to evaporate collectively 23,000 gallons of water in twenty-four hours and to have collectively not less than 1,170 square feet of surface; also, in the gunboat *Paducah*, there are specified two evaporators of a combined surface of 180 square feet which are to evaporate at least 3,500 gallons of water in twenty-four hours.

Q. 207.—Please give me through your Q. and A. the heating surface for a vertical water-tube suitable for triple expansion engine with cylinders 3, 5, and 8 inches diameter by 4 inches stroke, running at 400 revolutions by 5-8-inch cut-off on H. P. cylinder, the boiler pressure is to be 200 pounds. I wish to fit boiler for oil fuel burning. De B.

A.—There are two ways in which the heating surface may be figured for your engine: first, from calculating the cubic feet of steam used up to the point of cut-off per hour; second, by figuring up the estimated horse power, and assuming a certain efficiency of the engine. The processes are in brief as follows:

The capacity in cubic inches of the high-pressure cylinder up to the point of cut-off, or 5-8 of a stroke, is the area of the cylinder, $7.068 \times 2.5 = 17.67$ cubic inches. This space is filled with steam from the boiler twice in each revolution; thus, upon the up and down strokes, 800 times a minute, or 48,000 times an hour. Then reducing to cubic feet by dividing by 1,728, we have without allowance for the volume of the clearance space, as follows:

$$\frac{17.67 \times 48{,}000}{1{,}728} = 490.8 \text{ cubic feet per hour.}$$

We now assume that the steam pressure at the point of cut-off is 185 pounds gauge. At this pressure 1 cubic foot of steam weighs .44 pounds (this value can be found in any of the steam tables), therefore, the calculated number of pounds per hour is

$$490.8 \times .44 = 216 \text{ pounds.}$$

It is, however, probable that the steam will not be in a saturated condition at the point of cut-off. You can assume that it will be 95 per cent. dry. Also, the heating surface must be increased, for the feed water will probably be evaporated from a temperature less than the boiling point. Assuming that the temperature of the feed water will be 100 degrees, then to raise steam to 200 pounds pressure from this temperature of feed would require an extra amount of work to be expended, *i. e.*, coal burned. This amount may be also ascertained in the steam tables, and is called the factor of evaporation, which, under these conditions, is 1.171. Therefore, making the two corrections for quality of steam and evaporation factor, we have

$$216 \times 1.171 \times .95 = 266 \text{ pounds.}$$

In your type of boiler it will be safe to allow about 3 pounds of water evaporated per square foot of heating surface. Therefore, dividing this last figure by 3, we have 88.7 square feet of heating surface.

The second method requires first the horse power to be ascertained and is as follows:

The number of expansions of the steam from point of cut-off in the high-pressure cylinder to the full volume of the low-pressure cylinder is found by dividing the volume of the low-pressure cylinder, 205 cubic inches, by the volume of the high-pressure up to the point of cut-off, or 17.67 cubic inches, which is roughly 11 1-2. At this ratio of expansion, and assuming steam pressure at 185 pounds, it is found that the mean effective pressure referred to the low-pressure cylinder is 33 pounds, and the formula by which this is derived is as follows:

$$p_m = p_1 \frac{1 \times \text{hyp. log. } r.}{r}$$

in which p_1 = absolute initial pressure = 200 lbs.
p_m = mean effective pressure,
r = number of expansions = 11.5.

From steam tables it is found that for expansion of 11 1-2 the expression at the right hand = .3.

Then, $p_m = 200 \times .3 = 60$ pounds.

From this the back pressure of 5 pounds must be taken, assuming that you will run condensing, which leaves 55 pounds, which is the theoretical mean effective pressure. To reduce this to practice it must be multiplied by a card factor, which, for this engine, will probably be in the neighborhood of .6.

$$55 \times .6 = 33.$$

Multiplying now the mean effective pressure × the length of stroke in feet × the area of the L. P. cylinder in inches × the number of stroke, and dividing by a constant, will give the horse power as follows:

$$\frac{33 \times 1\text{-}3 \times 50.25 \times 800}{33{,}000} = 13.4 \text{ H. P.}$$

Assuming that your engine will require 20 pounds of steam per horse power per hour, the total steam per hour will be 268.

With the assumptions in these two cases the results come out very closely, and you can safely figure on 90 square feet of heating surface giving you all the steam necessary under good working conditions in a well-designed boiler for this engine.

Q. 208.—Will you kindly tell me what changes are necessary to a two-cycle gasoline engine to adapt it to the use of kerosene? Why is the jump spark generally not used on marine motors?
R. E. B.

A.—The difficulty in the way of using kerosene in place of gasoline is that kerosene does not volatilize as readily as does gasoline, and therefore does not so readily form an explosive mixture with air, which may be ignited by a spark. One form of kerosene explosive engine which has given very good satisfaction and is of the two-cycle type, compresses the air before the kerosene is taken in. At the end of compression, which is not over 40 pounds, the kerosene is sprayed in through a very fine nozzle, and the charge is ignited by an incandescent hollow ball placed at the top of the cylinder. Some makers are now fitting special feed appliances which permit kerosene to be used as a working fluid.

The answer to your query on Jump Spark is given in A. 202.

Q. 209.—Will you please advise if you consider a speed of 720 revolutions per minute in a four cycle 10-horse power double-cylinder engine the most economical and efficient for driving a cabin boat of say 35 feet length and 8 feet beam with torpedo stern.
W. D. L.

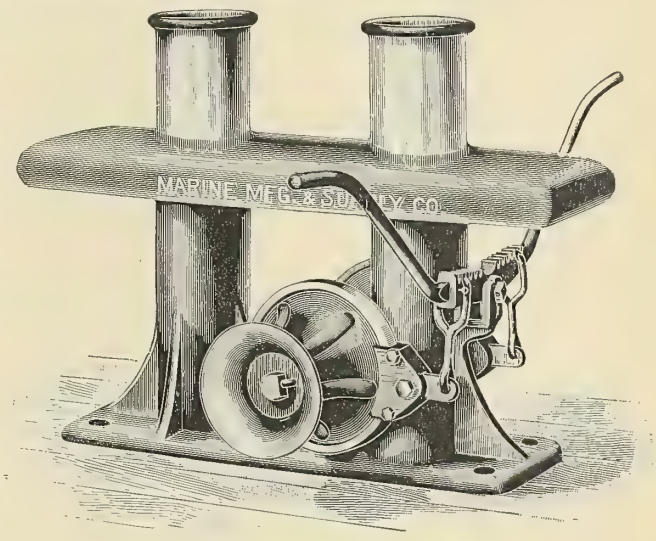
A.—The above speed will be all right. The engine will run more economically than at a slower speed. It may require a wheel with less pitch than a slow-speed motor, but will run the boat faster and at less cost.

New Turbine Manufacturers.—The Allis-Chalmers Company, Chicago, Ill., makes formal announcement of its purpose to engage in the manufacture of steam turbines, hydraulic machinery, gas engines and electrical machinery. The company has exclusive license from the Steam Turbine Advisory Syndicate of England to use its horizontal turbine for the United States, Canada and Mexico, which is a type much similar to that of Parsons, of England, and Brown-Boverie, of Switzerland.

ENGINEERING SPECIALTIES.

Iron Towing Bitts.

The superiority of the iron towing bitt over the more familiar wooden bitt is such that if clearly understood it is doubtful if the latter kind would be used at all. In the first place, the iron towing bitts are much stronger and more durable; then as they do not pass through the deck as the wooden bitts do, the space below is entirely clear and may be utilized for tanks, storage, or other purposes. The strains which come upon the bitts are such that to keep the deck tight around wooden bitts is practically impossible, which results in deterioration of the deck and in leakage. The iron bitts are bolted through the deck directly to the beams, and, when a reinforcing steel plate is placed under them, riveted to the beams, the construction is very strong and most satisfactory.



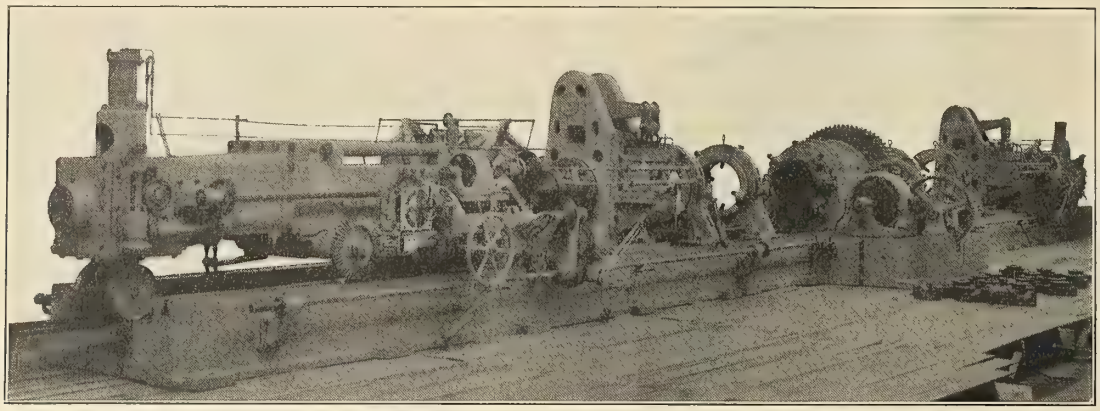
IRON TOWING BITT WITH PUMP BRAKE WINDLASS.

The double forward bitt here shown is made by the Marine Manufacturing & Supply Company, 157 South street, New York, N. Y. It is made in two sizes, 41 and 43 inches high over all, and weighing 1,800 and 2,400 pounds respectively. A special feature, as will be noticed, is the windlass which is located at the base in a space otherwise useless. The windlass is a pump brake friction windlass operated by hand.

Iron towing bitts are also made for mounting at the sides and at the stern, and the side bitts are so designed as to become an integral part of the vessel's frame, and thus add materially to the strength of the bulwarks.

Featherweight Air Pumps.

The Featherweight air pump is the type supplied the Russian Admiralty for the battleships *Alexander III.*, the *Oreal, Souvaroff*, and *Slava*. These pumps are built on the so-called suction valveless principle, as previously described in these columns, and are similar to those installed on several of the United States battleships. It is stated that on the official trial of the *Missouri* these pumps did their work with an expenditure of less than one-seventh of 1 per cent. of the I. H. P. of the main engines, and yet maintained a vacuum of over 26 inches.



14-INCH HYDRAULIC BORING LATHE SPECIALLY BUILT FOR BORING GUN FORGINGS AND MARINE SHAFTING.

14-Inch Hydraulic Boring Lathe.

The machine illustrated herewith and made by the Niles-Bement-Pond Company, 136 Liberty street, New York, N. Y., is intended to bore gun forgings, marine shafts, and ingots generally. It will take in a shaft 60 feet long, 30 inches in diameter, and bore a hole out of the solid 12 inches in diameter the full length, or 14 inches for short length.

Two boring bars are used, one at each end, while the work is being held in a hollow spindle or revolving chuck. Two, revolving, ring steady rests on each side of the center chuck support the work. The feed pressure required to do such extremely heavy work is so great that it becomes impractical to feed by rack and pinion or screw. For this reason the boring bars are fed in by hydraulic pressure. The boring bar itself is clamped in a head by means of hydraulic pressure, in addition to lever and toggle joint. The hydraulic pressure against the piston is 720 pounds per square inch, giving a total pressure of 200,000 pounds against the piston.

It is obvious that an arrangement like this would allow the tool to gouge into the work should the metal be soft, and, generally speaking, would not offer any means of control of the feed. In order to provide for this control, the rear end of the piston, that is, the end projecting backward from the cylinder, is cut as a very steep screw. A nut revolving on this screw has a worm wheel with very steep pitch cut on its outer circumference. The angles of the screw and the worm are so chosen that the pressure against the piston will be able to revolve the nut, and the movement of the nut will be able to revolve the worm, but a relatively small amount of resistance on the worm will entirely check this movement. This amount of resistance is provided by ordinary feed mechanism taken from friction discs, which have the necessary change gears, etc., to enable the operator to get any feed desired. It will be seen, therefore, that the hydraulic cylinder furnishes the pressure and the feed mechanism furnishes the amount of feed, but that the feed mechanism is never subjected to the heavy strains due to the exceedingly heavy work to be done on this machine.

The illustration shows the drive of this machine. It is driven by a 100 horse power Westinghouse motor, 220 volts. A motor of this make and size always allows of some speed variation by means of field control. The range of speed is increased by change gears, which are also clearly visible in the illustration. The piece to be bored is chucked by means of eight set screws, 3 1-2 inches in diameter, on each side of the machine.

The feed is taken from the last driving shaft, and is transmitted to the two cylinders by means of the long shaft running alongside and in front of the bed. This shaft is supported by drop bearings and is made in three pieces coupled together. Change gears and friction discs give a wide range of feeds.

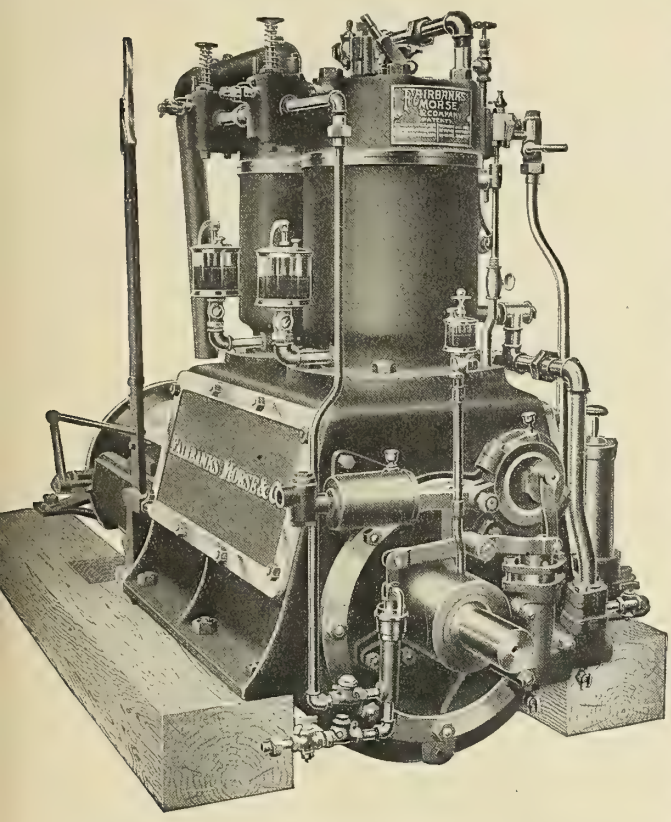
A hand feed is provided for by means of hand wheel. Before using this hand wheel, friction discs and feed driving shaft are disconnected by means of hand-wheel. A 5-H. P. motor gives a fast motion to a train of gearing, whereas the feed mechanism gives a slow motion to this train. Clutch-levers throw in either one or the other, and thus give either a slow feed or a quick traverse of 10 feet per minute to the piston, and, if the cylinder is clamped to the bed, also to the clamping-head, or, if the clamping-head is clamped to the bed, it gives this quick traverse to the cylinder. This quick traverse is really gotten by means of hydraulic pressure in the cylinder, and the small motor only regulates the speed. A hand-wheel gives adjustment to the piston and clamp-head, or to the cylinder, should this latter be clamped to the bed.

The train of gearing moved by the motor can be connected to the cylinder mechanism, or it can be connected to the shaft, which, by means of suitable gearing, drives a grooved roll, which is not visible in the illustration, but which is held in a floating frame inside of the rear part of the cylinder casting. This floating frame carries the hydraulic cylinder, the piston of which is connected to this grooved roll while the cylinder casting is connected to two other rollers under the bar. By admitting water in this cylinder the inner boring-bar is clamped between the rollers, and by moving the grooved roll a quick traverse motion is imparted to this inner bar.

The mode of operating this machine is to force 4 feet of the boring-bar into the work. By that time the clamping-head is up to the work and 4 feet distant from the cylinder. The quick traverse is then brought into play and the clamping-head is pulled back until it comes up

to the cylinder. The inner boring-bar is then pushed 4 feet further forward and the boring-bar is once more forced into the work another 4 feet. This alternate action of forcing the bar into the work and drawing the clamping-back so as to take a new grip is repeated until the center of the work is reached.

The piping for the different cylinders is at the rear of the machine supported in brackets or rollers where the piping is sliding. There are handles for operating the various valves both on the front and rear sides of the machine.



4-CYCLE MARINE GASOLINE ENGINE.

Gasoline Marine Engine.

For a number of years Fairbanks, Morse & Company, Chicago, Ill., have been building extensively gasoline engines up to 10 horse power, but of late years the company has added new sizes, the largest being 150 horse power. These engines are all of the four-cycle type with either two, three, or four cylinders, depending on the horse power of the engine. Each cylinder is a separate casting and water jacketed at sides and on head. They are mounted on inclosed crank case with hand hole and removable plate at side, thus all the bearings and working parts within the crank case are accessible. Each bearing and working part is positively lubricated from a sight feed lubricator, and, in addition, the pistons dip into oil rings, distributing oil to the cylinder walls, and splash lubrication in the crank pit may be obtained if desired.

The admission and exhaust valves are on the head of the cylinder. Each cylinder is fitted with a special gasoline fed reservoir, which is fed by a pump, direct connected to the engine, with gasoline drawn from the main tank. Thus there is but a small supply of gasoline at the engine in the reservoir, and the feed is shut off when the engine stops running.

It will be seen from the cut herewith of engine with flywheel removed that a water pump and an air pump, both operated from the side shaft of the engine, are conveniently attached to the base. The water pump is used for supplying circulating water for cooling the engine cylinders. The air pump supplies air for operating whistle for signalling. The starting gear consists of a hand charging air pump which pumps the first charge into one of the cylinders. This charge is then ignited by means of the improved and patented electric igniter. The explosion of this first charge starts the engine in motion, and the other cylinders then draw in their charges and explode them in succession, putting the engine rapidly and easily into full motion. The engines are fitted with a governor so that there is no chance of racing when the screw is out of water.

Reversal of the engine is accomplished by a friction clutch arranged in an extended casing at the after end of the engine base, and controlled by a lever seen at the left of the illustration. When forward motion is desired the lever is thrown forward and couples all parts rigidly together, so that the gear travels in same direction as the engine shaft, acting as a balance wheel in addition to the flywheel. No gears are in contact when the lever is in this position. When thrown aft the lever throws out the clutch connecting the reversing gears and causes the propeller and shaft to rotate in reversed direction. The intermediate position of the lever allows the engine to run free. The blades of the propeller are so arranged that the pitch may be set at any desired point.

Conveniently placed either on the engine or at any other desired point, is a controlling lever acting on the engine governor, making it possible to run the engine at any desired speed between its mimimum and maximum speeds. This device is especially valuable when making a landing or when it is desired to run at slow speed.

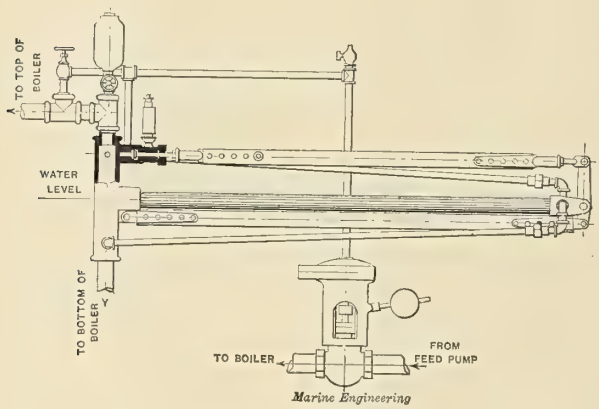
This company has brought out a marine engine which in all important respects resembles the gasoline engine herewith described, but which uses kerosene oil, the only difference being a slight modification in the feeding device attached to each cylinder. No doubt this feature will recommend the engine to many who have desired to use other power than steam, yet do not care to intall such an inflammable fuel as gasoline.

Feed-Water Regulator.

A feed-water regulator has been placed on the market which has for its actuating principal the expansion and contraction of copper pipe, which is always positive in action. The apparatus, known as the Buffalo Feed-Water Regulator, made by Robert Learmonth, 100 White Building, Buffalo, N. Y., is a device guaranteed to maintain water at a level varying only two or three inches in height regardless of the pressure of steam in the boilers, so long as there is any steam present. The amount of heat in steam is much greater than that in water under the same pressure, and regulation in this device is accomplished by the expansion or contraction

of a copper tube connected with the boiler and placed horizontally at the level of the water line, due to the tube being filled with either steam or water.

When the water in the boiler is at its normal level, the tube is filled with water, cooling it and causing it to contract and become shorter, and when the water is below the normal level in the boiler the tube is filled with steam, causing a rise of temperature in the tube, making it longer. This lengthening and shortening of the copper tube gives motion to a small valve, shown in the upright column, which increases the pressure on the regulating valve, or releases it, as the case may be, to supply the water needed to maintain the desired quantity in the steam boiler.



EXPANSION FEED WATER HEATER.

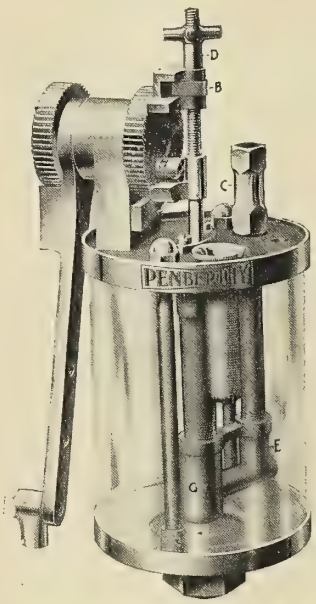
The device will regulate the water supply in any of the following ways: First, by throttling the steam supply to the pump; second, by shutting off the water from going into the boiler, and third, by allowing the surplus water to escape or flow back to the pump. The device not only regulates the supply of water but it also gives warning when the water level is low, by the steam in the pipe blowing a small whistle, thus there is no danger of the engineer forgetting to look after the water supply of the boiler. The manufacturer guarantees each regulator to work perfectly well or he will take it back and refund the money.

Force Feed Lubricator.

One of the latest inventions in this class of lubricators is shown in the annexed cut. Its principal features are, first, the two ratchets, one of which is used to drive the plunger, while the other acts on the plunger itself, and secondly, the location of the valves which are in the center of the oil reservoir.

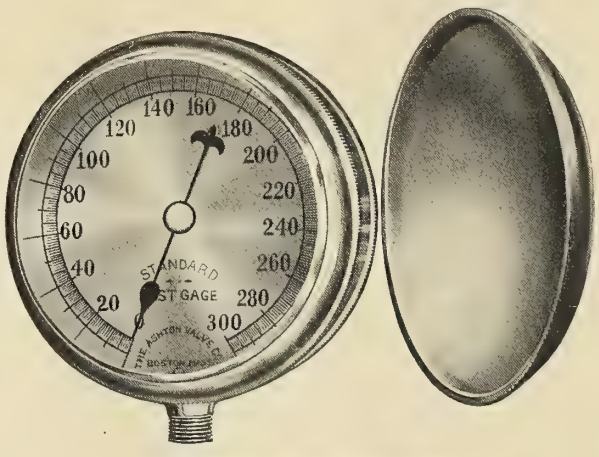
The advantage of two ratchets is that they are interchangeable, and as the wear only comes on the outer ratchet to which the lever is attached, when one of the ratchets is worn to such an extent that the "dog" will not hold, it can be replaced by the ratchet acting on the plunger, and the life of the lubricator thereby doubled. As the ratchet is the first thing to wear out, this device will be appreciated by engineers.

The advantage of having the valve and feed at the center of oil reservoir is that they cannot be affected by changes of temperature, and it will therefore feed oils very difficult to feed through hydrostatic cups.



LUBRICATOR OF THE FORCED FEED TYPE.

Closing jaws of lubricator with the nut *B* increases the feed, opening decreases the feed. When the proper amount of oil is being fed, screw down the lock nut *D* to hold rigidly in place. Extra oil can be had by screwing down the nut *B* and operating the plunger by hand. The cup can be cleaned from a hole in the bottom designed for that purpose. This cup is manufactured by the Penberthy Injector Co., of Detroit, Mich.



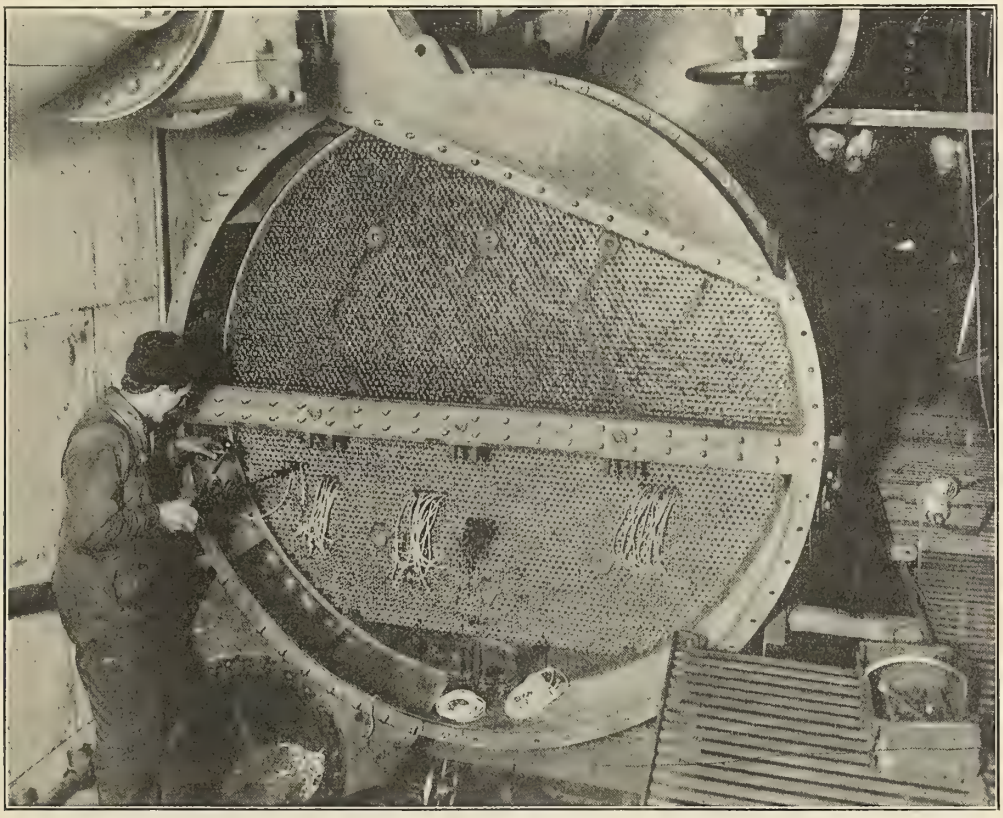
AN ENGINEER'S SMALL TEST GAUGE.

Pocket Test Gauge.

To meet the demand for a neat, light, and accurate test gauge of a suitable size, and so constructed that it can be carried in the pocket, without danger of injury, the Ashton Valve Company, 271 Franklin street, Boston,

Mass., has brought out the Standard pocket test gauge shown in the cut on page 196. It is particularly designed to meet these requirements as it is made with a beveled plate glass front and fitted with a cover to insure protection.

This gauge, like other Ashton gauges, is made with a spring of solid drawn seamless tubing with a non-corrosive movement, and is the best that high grade material and workmanship can produce. The gauge is of the 3-inch size with the dial graduated for any pressure up to an including 500 pounds. It is made in full nickel plate and weighs when completed with cover about one pound.



A LABOR SAVING MACHINE FOR PACKING THE TUBE ENDS OF SURFACE CONDENSERS.

Machine for Packing Tube Ends of Surface Condensers.

A little device herewith illustrated bids fair to save a great deal of labor in any machine shop were surface condensers are made. It has been brought out by Mr. John Schlosser of Cramp's Shipyard, and is devised to pack in a very short time the tube ends of surface condensers, which operation has heretofore been a long and tedious one. The device consists of a small tool used in connection with an ordinary bit brace, breast drill or with a small pneumatic drill. With this tool a corset lacing can be wound in place it is claimed in less than half the time required by the old method, and insures far better results.

Mr. Schlosser contracted for packing the condensers of the new cruisers *Pennsylvania* and *Colorado,* nearing completion, and established a record of packing 1200 tube ends in five and one-quarter hours, and three thousand tubes ends in fifteen hours. On the whole job, which amounted to 11,360 tubes or double that number of ends, he effected a saving for the shipbuilding company of over 60 per cent. of the former prices paid for such work.

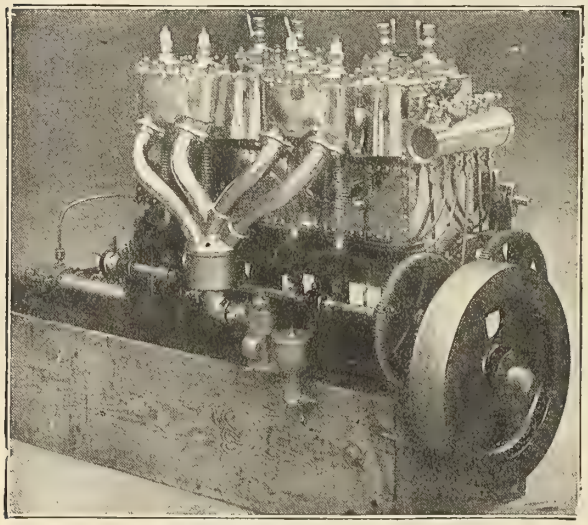
The tool has been placed in the hands of Matteson & Drake, 706-707 Bourse, Philadelphia, as sole manufacturing and sales agents for the United States, who in turn will arrange for distributing agencies in the different cities of the Atlantic and Pacific seaboards, for handling the tool.

New Marine Gasoline Engine.

To meet the demands of a strictly marine engine for small power boats, there has recently been placed on the market by the Yacht, Gas Engine, & Launch Company, Bourse Building, Philadelphia, Pa., the Crown yacht engine illustrated on page 198. It is claimed that marine steam engine lines have been followed as far as possible in the design of this gas engine. Best grades of steel, bronze, and cast iron have been used. In the 10-horse power size, two cylinders are supplied, and for 20-horse power, the two 10-horse power units are bolted together. The cylinders are of the best gray iron cast in pairs without a water jacket and with solid heads. The pistons are fitted with three rings and have special provision for lubrication. The bedplate is a single casting and supports the cylinders by means of eight steel

stanchions. The main journals have specially large bearing surface and are poured with a combination of government bronze and Parson's white metal which, it is claimed, has a very long life.

The water jacket is made of Victor non-corrosive silver metal, which is non-galvanic and much lighter than cast iron, the circulation is around the valve chambers over the top and around each cylinder. The crank shafts are open hearth steel and the connecting rods are of forged steel milled to I-beam section and fitted with government bronze crank pin ends and phosphor bronze piston ends. The cams are of drop forged steel. Cast iron valves are used and a tapered plug is placed over each, so that the valve may be easily taken out if necessary. Steel rollers are placed in the valve stem guides to overcome the friction due to side thrust of the cams.



NEW TYPE OF MARINE GASOLINE ENGINE.

Each piston has an oil pipe leading to each side, and each main bearing has a pipe coming from a multiple oiler, while the connecting rods are fitted with brass rollers. The Holley carburetter and Herz commutator and jump spark are fitted. The weight of the 10-horse power engine is but 500 pounds completed with reversing gear. The engine is so designed that any part can be removed without disturbing or dismantling any other part.

The "Patternmaker."—A new monthly magazine has been issued by the Iron and Steel Press Company, Rose Building, Cleveland, O., and called the *Patternmaker*. As the name implies, the paper is to be devoted to the whole patternmaking trade, including the shop owners, manufacturers, foremen, and workmen, and will deal with all phases of the business, including both wood and metal patternmaking. Mr. Henry M. Lane, the editor, promises to present articles describing new appliances, foundry conditions, current practice, etc., and it is intended to make the magazine a "direct bond between the manufacturer of patternmaking supplies and machinery, and the users." The first issue is that of March and contains 38 pages of good reading matter and an equal amount of advertising.

TECHNICAL PUBLICATIONS.

A Manual of Marine Engineering. By A. E. Seaton. Size, 6 by 9 inches. Pp. 707, with 230 figures and illustrations in the text. London and New York, D. Van Nostrand Co. Price, $6.00.

This work has long been a standard in the field of marine design, and since the appearance of the first edition in 1883, it has held its place and steadily grown in favor as successive editions have appeared. This edition is the fifteenth, and represents a more complete and thorough revision than many of its predecessors, and constitutes, according to the author's preface, practically a new book. As stated by the author in his earliest preface the fundamental purpose of the work was in effect to provide aid to the designer of marine machinery in the application of scientific principles to the problems which he is called on day by day to solve, and to show the general condition of the best practice in this field of engineering work. This aim has been consistently held in view throughout, and the gratifying reception which the work has been accorded is an indication of the real need which has existed for such a work.

The book is divided into twenty-six chapters which, as a whole, are intended to cover the general field of marine practice, with especial reference to the designing aspect of the work. Naturally, however, the book contains a large amount of descriptive matter and general discussion, such features being a necessity in a book treating the general subject of design. Again the discussion of design necessarily appears under two aspects, the determination of general characteristics and proportions, and the determination of detail dimensions and of structure. The former has reference to the fulfillment of the general conditions, regarding capacity, efficiency, &c., while the latter has special reference to the provision of strength and other engineering qualities as provided by the various materials of construction best suited to the special requirements involved.

The first chapter is chiefly concerned with the history of the development of the various types of marine engines which have appeared prominently since the early beginnings of steam navigation. In the following chapter the author gives a general discussion of horse power, both nominal and indicated, together with a brief presentation of the general theory of the steam engine and of its various efficiencies, thermodynamic and mechanical. The most valuable feature of the chapter is found in this general discussion of the steam engine, and of the various losses of useful effect between the boiler and the propeller shaft.

The following chapter deals with the subject of resistance and propulsion and the powering of ships. This important chapter has reference to the general purpose of the book in so far as it has to deal directly with the power required to obtain a given speed, and also with the propeller which is intended to absorb this power with the highest obtainable efficiency, and to develop thereby the thrust necessary for the propulsion of the ship.

The following three chapters deal with the marine steam engine with reference to type, space required in the ship, principles of economy, operation under the prevailing conditions in marine practice, and with

various other aspects of the steam engine not coming under the direct head of structural design. Then follow ten chapters dealing with the general subject of the design of the engine considered as an engineering structure, and involving a discussion of the principles which should govern the determination of the most suitable dimensions for the various structural items of the machinery. These chapters include also reference to the chief items of auxiliary machinery, to problems of valve gear design and to the valve gear diagrams in common use for the solution of such problems. One entire chapter of this section of the work is given to the design of the screw propeller and paddle-wheel as instruments of propulsion, and various practical rules of design are given, both with reference to the determination of structure and of general dimensions.

The following five chapters deal with marine boilers in the same comprehensive manner. Fuels, combustion, natural and forced draft, the evaporated capacity of boilers, the general design and proportion of Scotch boilers, descriptions and discussion of the leading varieties of water tube boilers, boiler mountings and fittings; these various items receive due consideration and extended reference is made to the various rules and regulations of registration societies regarding the details of boiler design and construction. These chapters are followed by a chapter on the erection of machinery on board ship, and including descriptions of various items of auxiliary machinery and special equipment.

Chapter xxiii, which follows, contains matter practically new in the present edition, and dealing with the weight of marine machinery in its various aspects and relations, and with the considerations which may influence its amount in any given case. A feature of special value in this chapter is found in a table giving the safe working stresses as proposed by the author for all classes of materials and according as the stress to which they are subject is steady, intermittent or alternating. The experiences of recent years in high speed practice have impressed on engineers the necessity of some distinction between working stresses with especial reference to the character of the stresses involved, and designers will gladly welcome these suggestions as to safe working limits from one with so wide an experience as the author of this work. Of especial note in this table is the distinction between intermittent and alternating stresses. The former are defined as stresses always acting in the same direction but varying in amount or intermittent in character, while by the latter are implied stresses alternating in direction or character.

The following chapter on inertia forces and balancing is also essentially new in the present edition. This general topic is likewise one which has come largely to the front in the past few years, and no marine design of importance can be considered complete which does not include an examination of the inertia forces developed, and of the best methods for effecting a dynamic balance of the moving parts of the engine. A general discussion of the topic is given, with rules for analysis and for the determination of the most practicable conditions for reducing the resultant inertia forces to the smallest possible values. Naturally vector processes are recommended for the combination of the various inertia forces for a series of moving parts, and the general principles of such analysis and combination are clearly presented and discussed with reference to the cases most commonly met with in such problems.

The following chapter on the materials of engineering has also been greatly extended in the present edition, and a large amount of most valuable information is given with reference to the various materials at the disposal of the designing or constructing engineer. The following and last chapter is new in the present edition, and deals with the general subject of oils and lubrication. This chapter will be welcomed as dealing with a topic too commonly overlooked in the literature of marine construction, but none the less of the highest importance both for the designing and for the operative marine engineer.

Following this chapter are found some 80 pages of appendix, consisting for the most part of the rules of the various registration or classification societies and forming for the designer a most convenient collection of these various sets of rules and regulations.

We have given but inadequately a general sketch of the contents of this extended treatise, with special reference to the features which are new in the present edition. Much of the work naturally remains essentially as in previous editions. Some features are quite out of date and might better have been omitted, as for example reference to Rankine's augmented surface method for powering ships, and some portions of weight and general engine and boiler data in chapter xxiii. Again the absence of any adequate discussion of the application of Froude's law of comparison for powering ships, or of reference to the experiments of Mr. R. E. Froude relating to screw propellers or to the methods of design based thereon and devised by Barnaby and others, may be noted as somewhat surprising in a work otherwise so comprehensive and so exhaustive in many directions. As a whole, however, the book stands conspicuous in the field of engineering literature, and has well deserved the wide and long continued favor with which it has been received through the many editions from the first. The present edition marks a decided advance over its predecessors, and may be most cordially commended to the profession as a safe and conservative guide in the study of the many problems which arise in the broad field of marine design.

The Factory Manager and Accountant. By Horace Lucian Arnold (Henry Roland). Size, 6 1-2 by 9 1-2 inches. Pp. 431, with numerous figures and forms. The Engineering Magazine, New York and London. Price, $5.00.

This book is an expression of the general appreciation which the industrial world has come to have in recent years regarding the value of carefully studied systems of cost and commercial accounting as essentials of good engineering and business practice. The book comprises descriptions of several complete systems of factory accounting, with reproductions of the blanks and forms employed, each one having complete specifications as to size, color, material, arrangement, exact function, etc.

The descriptive matter is furthermore given in such detail as to show the purpose and complete function of each form with its relation to the others employed, so that a careful study of these systems will serve to give to the reader not only a comprehensive idea of the

modern methods of cost and commercial accounting for industrial engineering purposes, but also specific suggestions and information of value for particular cases which may be under consideration. The fundamental purpose of a cost accounting system is to furnish an answer in detail to any question which may arise as to the cost of the production and marketing of an industrial article, as dependent on raw material, manufacturing processes and marketing, with its due share of fixed charges for interest, insurance, depreciation, engineering and salary charges, etc., and all in such form as to give answers to such questions with the minimum demand for time and with the maximum adaptability for grouping items of various kinds in various ways for purposes of comparison and of study with reference to increased economy of future production.

The present book goes far toward showing how many or most of these various demands may be realized in various kinds of industrial work, and its careful perusal is commended to all who may have dealings with problems of this character.

SELECTED MARINE PATENTS.

750,322. BUOY FOR SUNKEN VESSELS. JOSEPH F. TRIBBLE, NORWICH, CONN., ASSIGNOR OF ONE-HALF TO AGNES V. PEABODY, WORCESTER, MASS.

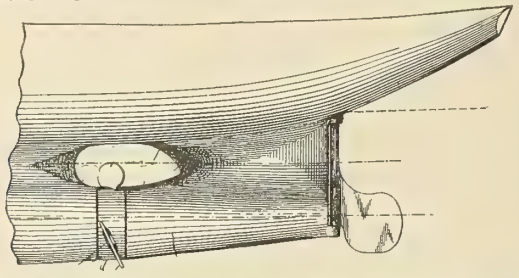
Claim.—1. In a buoy for sunken vessels, the combination of an airchamber, a chamber containing a reel with cable wound thereon and separable from said air-chamber, means for detachably securing said air-chamber and said reel-chamber together, with the axis of said reel-chamber coincident with the axis of said air-chamber. One claim.

750,533. JET PROPULSION APPARATUS FOR VESSELS. SEYMOUR GEORGE, PITTSBURG, PA., ASSIGNOR OF ONE-HALF TO CHARLES FRANCIS HARRIS, PITTSBURG, PA.

Claim.—1. In a jet propulsion apparatus for vessels, the combination with a rotary pump and means for operating the pump, of a jet mechanism having a discharge-pipe connected to the pump and provided with a siphon which extends considerably above the normal water-line of the vessel. One claim.

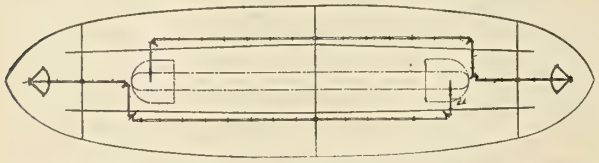
750,812. OAR-LOCK. ARCH D. COLLINS, LAWTON, VA. One claim.

751,158. PROPELLER-SHIP. CARL J. H. FLINDT, HOBOKEN, N. J.



Claim.—1. The combination in a ship having a rudder at its stern, of a hull, a propeller having blades and carried by the hull at its rear but at a distance considerably forward of the rudder; an opening through the hull to admit the passage of the propeller-blades from one side thereof to the other, the walls surrounding such opening having guide-faces projecting generally in the direction of flow of the water incident to the movement of the propeller-blades. One claim.

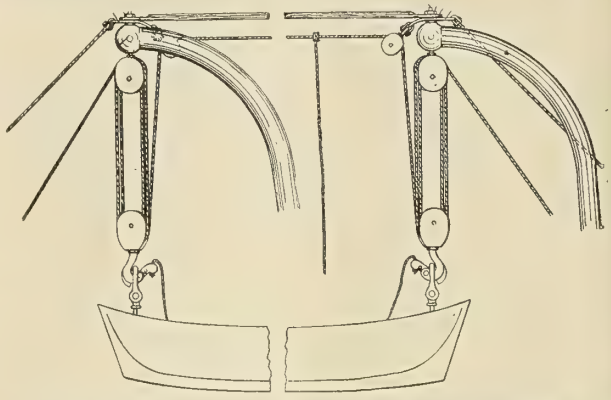
752,086. MEANS FOR LOCKING OR UNLOCKING RUDDERS. ALEXANDER J. MACLEAN, NEW YORK, N. Y.



Claim.—1. In rudder locking and unlocking means, the combination with a rudder and a horizontally-movable frame connected therewith and embodying a curved plate containing an opening, of a bolt repressed by said plate at either side of the opening, but adapted to enter the latter and lock the frame when the rudder is in a central position.

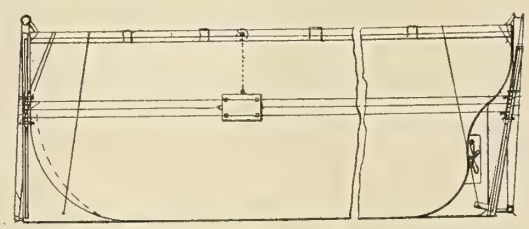
2. The combination with a boat and its rudder, of a horizontally-movable part connected with the rudder, a bolt repressed by said part when the rudder occupies a central position, said horizontally-movable part adapted to become engaged and locked by the bolt when the rudder is in a central position, and connections extending to a relatively remote point on the boat for operating the bolt. Three claims.

751,205. BOAT-DETACHING APPARATUS. JAMES R. RAYMOND, BAYONNE, N. J.



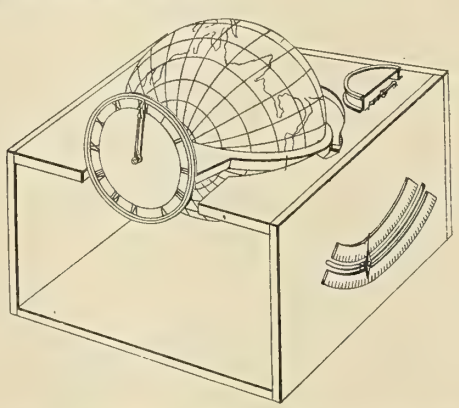
Claim.—1. In boat-detaching apparatus, the combination in the tackle-hook which engages a shackle on the boat of a body part, a weighted bill pivotally connected thereto, and a projection on said body part adapted to prevent the shackle from jumping back on said body part. Six claims.

752,142. SHIP-CLEANING DEVICE. EDWARD COLE, NEW YORK, N. Y. FILED JUNE 13, 1900. RENEWED JULY 21, 1903.



Claim.—1. In a ship-cleaning device, the combination of a scraping mechanism, a vertically adjustable and longitudinally-extending suspending means adapted to remain stationary while the scraping mechanism travels over the same, and an adjustable, vertical suspending means adapted to travel longitudinally with the scraping mechanism. Eleven claims.

752,717. NAVIGATOR'S POSITION-INDICATOR. JOHN B. SMITH, VALDOSTA, GA.



Claim.—1. The combination of a terrestrial globe mounted for adjustment to position corresponding to the relative position of earth and sun, and an opaque body disposed in proper position relative to the globe for casting a shadow thereon to indicate the location of the instrument at the time the observation is made. One claim.

752,670. PROPELLER. EDWARD D. HAMILTON, VANCOUVER, WASH.

Claim.—1. The combination with a shaft having dovetailed mortises therein, of a hub having on the inside tenons fitting said mortises and on the outside similar dovetailed mortises, and blades having bases fitting the mortises in the hub. Two claims.